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Contents of Volume XIX.

DATES OF PUBLICATION OF AUTHORS' SEPARATES.

Art. I, March 4.
" II, " 21.
" III, " 20.
" IV, " 31.
" V, May 9.
" VI, " 9.
" VII, " 9.
" VIII, July 11.
" IX, " 8.
" X, " 8.
" XI, " 8.
" XII, " 23.
" XIII, " 24.
" XIV, " 24.
" XV, Aug. 10.
" XVI, " 10.
Art. XVII, Aug. 17.
" XVIII, Oct. 15.
" XIX, Sept. 9.
" XX, " 26.
" XXI, Oct. 10.
" XXII, " 28.
" XXIII, " 24.
" XXIV, Nov. 12.
" XXV, " 14.
" XXVI, " 21.
" XXVII, " 21.
" XXVIII, " 21.
" XXIX, Dec. 5.
" XXX, " 24.
" XXXI, " 24.

The edition of separates from the present volume was 350, of which 100 were for the authors, and 250 for the Library exchange list and for sale.

LIST OF ILLUSTRATIONS.

Plates.

Text Figures.

LIST OF HIGHER GROUPS, GENERA, SPECIES, AND SUBSPECIES, DESCRIBED OR RENAMED IN THIS VOLUME.

Families.

Genera.

Species and Subspecies.

ERRATA.

Page 91, line 9 from top, for JORLAN read JORDAN.
Page 447, center heading, for **bicalaratus** read **bicalcaratus**.
Page 524, last line, for Sorex longicauda read Sorex longicaudata.
Page 537, line 14, for Wrangel Island, Alaska, read western end of Alaska Peninsula.[1]
Page 566, line 8, for **Sorex longicauda** (*Merriam*) read **Sorex longicaudata** (*Merriam*).

[1] The type of *Citellus stonei* proves to have been collected on the western end of the Alaska Peninsula, opposite the Shumagin Islands, instead of on Wrangel Island. Through some mistake the label bore, in pencil, the erroneous locality of Wrangel Island.

BULLETIN

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VOLUME XIX, 1903.

Article I.— ON CERTAIN GENERA AND SPECIES OF NORTH AMERICAN CRETACEOUS ACTINOPTEROUS FISHES.

By O. P. HAY.

PLATES I–V, AND 72 TEXT FIGURES.

The present paper has resulted from observations made by the author on Cretaceous fishes in the course of his work of identifying, cataloguing, and arranging the Cope Collection of fishes and reptiles, now the property of the American Museum of Natural History. In this collection are most of the types of the fishes which Professor Cope described from the Cretaceous deposits of Kansas, South Dakota, and New Jersey; and there are likewise many other specimens which had not been carefully identified and studied. A comparison of these materials with the types, and of the types with one another, and an estimation of the value of the proposed species in the light of work done by more recent investigators, have resulted in the reduction of a considerable number of nominal species to the position of synonyms. Many of Cope's types have hitherto never been figured and the opportunity offered by the liberality of the Museum authorities has been employed to furnish many drawings and photographic reproductions of interesting specimens. My thanks are especially due to Prof. Henry F. Osborn for the opportunity to prepare and present this

paper. Of the drawings, Mr. R. Weber has made numbers 27, 58, 59, 60, 61, 62, and 65. All the others, except 32 and 72, have been prepared by Mrs. L. M. Sterling. The photographs for the plates have been made by Mr. A. E. Anderson, photographer of the Palæontological Department.

PROTOSPHYRÆNIDÆ.

The genus *Protosphyræna* is referred by Dr. A. S. Woodward to the Pachycormidæ; and in this procedure he is followed by Loomis (Palæontogr., XLVI, 1900, p. 221), by Stewart (Univ. Geol. Surv. Kan., VI, 1900, p. 362), and by the present writer (Bibliog. and Cat. Foss. Vert. N. A., 1902, p. 378). A reconsideration of the subject and the study of the materials at hand in this Museum have led me to a different view.

If we refer the genus to this family we must assume that the vertebral column was not at all ossified or only feebly so. That it was composed of well ossified vertebræ cannot yet be proved. However, accompanying the type of *P. dimidiata* there is a single vertebra which belonged close to the skull. It is figured on page 19. This vertebra may be an intrusion from some other fish, but there is nothing in its appearance to suggest this.

So far as the writer can gather from the literature, neither the Isopholidæ, hitherto called Eugnathidæ, nor the Pachycormidæ, possess ossified scapulæ and coracoids. Even the members of the more advanced family Amiidæ, with well developed vertebræ, have scapulæ and coracoids cartilaginous. *Protosphyræna*, on the other hand, has the elements of the shoulder girdle developed as in the modern Isospondyli. While there may be no necessary connection between an ossified shoulder girdle and ossified vertebræ, it seems logical to believe that, when the shoulder girdle is so advanced in its development as it is in *Protosphyræna*, there were probably also well defined vertebræ. It is remarkable that vertebræ have not been certainly collected, but neither has the tail fin been obtained, nor the anal, nor the dorsal fin.

It is proper to add to the above paragraph the statement

that in a specimen of *Hypsocormus* from Solenhofen, which the writer has been able to examine, there are evidences of the presence of ossified scapula and coracoid. If this shall prove to be the case, the fact that these elements are ossified in *Protosphyræna* will have no bearing on the question regarding the presence of vertebræ.

While there are many interesting and important characters common to *Hypsocormus* and *Protosphyræna*, there are also many striking differences. I regard the deeply socketed teeth of *Protosphyræna* as furnishing a character of family value. Woodward indeed states that the teeth of *Hypsocormus* are in incomplete sockets, those of the dentary of *H. tenuirostris* (Cat. Foss. Fishes, IV, p. 397) being fused with the bone in sockets which are incomplete on the inner side. The condition of such teeth is certainly very different from that of the teeth of *Protosphyræna*, which are in complete and very deep sockets. It evidently signifies a great departure from the primitive condition in fishes, when teeth become so deeply implanted in the bone and are replaced, not by new teeth developing in the mucous membrane of the mouth, but from germs lodged deep in sockets.

The pectoral fin of *Protosphyræna* is quite different from that of *Hypsocormus*, as may be seen by comparing the description and figures of *P. perniciosa* presented in this paper with the description of the fin given by Dr. Woodward on page 398 of the work cited above. In *Protosphyræna* there is no such intimate fusion of rays and the foremost rays are extremely short.

The condition of the shoulder girdle of *Protosphyræna* would appear to relegate the genus to the Isospondyli. Whether the possession of a splenial and a slight excess of baseosts is sufficient to exclude it from this order may have to be determined hereafter. At any rate, the genus is close to the border line between the Halecomorphi and the Isospondyli.

Protosphyræna nitida (*Cope*).

Erisichthe nitida Cope (E.D.), Proc. Acad. Nat. Sci. Phila. 1872, p. 280; Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1874, p. 42;

Vert. Cret. Form. West, 1875, pp. 217, 275, pl. xlviii, figs. 3–8; Bull. U. S. Geol. and Geog. Surv. Terrs. III, 1877, p. 821 (in part).

Protosphyræna nitida Newton (E. T.), Quart. Jour. Geol. Soc. XXXIV, 1878, p. 794.—Felix (J.), Zeitschr. deutsch. geol. Gesellsch. XLII, 1890, p. 278 (in part).—Woodward (A. S.), Cat. Foss. Fishes Brit. Mus. III, 1895, p. 409.—Loomis (F. B.), Palæontogr. XLVI, 1900, p. 227 (in part only).—Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

Pelecopterus chirurgus Cope (E. D.), Vert. Cret. Form. West, 1875, pp. 244E, 273, pl. xlviii, fig. 1; pl. liv, fig. 9.

Protosphyræna chirurgus Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

Erisichthe penetrans Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. III, 1877, p. 822.

Protosphyræna penetrans Newton (E. T.), Quart. Jour. Geol. Soc. XXXIV, 1878, p. 795.—Felix (J.), Zeitschr. deutsch. geol. Gesellsch. XLII, 1890, p. 297, pl. xiv, fig. 1.—Crook (A. R.), Palæontogr. XXXIX, 1892, p. 109.—Woodward (A. S.), Cat. Foss. Fishes Brit. Mus. III, 1895, p. 409.—Stewart (A.), Kan. Univ. Quart. VII, A. 1898, p. 192; Univ. Geol. Surv. Kansas, VI, 1900, p. 369, pl. lxiii, fig. 4.—Loomis (F. B.), Palæontogr. XLVI, 1900, p. 227, pl. xix, figs. 1–5.—Hay (O. P.) Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

Protosphyræna obliquidens Loomis (F. B.), Palæontogr. XLVI, 1900, p. 225, pl. xx, figs. 1–4.—Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

The type of Professor Cope's *Erisichthe nitida* is now in the American Museum of Natural History. It consists of both premaxillæ, a portion of the left dentary, and the adhering postsplenial, the supposed hyomandibular, and a bone (Vert. Cret. Form. West, pl. xlviii, fig. 7) which is as yet unidentified. Of the same specimen Cope possessed also a fragment of the fin, which lacked the anterior edge and was therefore not susceptible of comparison with other species based on parts of fins. This fragment is now missing. Dr. Loomis (Palæontogr., XLVI, p. 228) has questioned that the fragment of the dentary figured by Cope belongs with the premaxilla; but there is no reason to doubt that all the parts of the type belong to the same individual. As regards the premaxilla it may be remarked that the anterior fang is probably directed more horizontally forward than is natural, a fact due to pressure.

In 1877, Cope, as cited, described from materials collected in Gove County, Kansas, by Mr. Russell Hill, a species which he called *Erisichthe penetrans*. The type, never figured hitherto, is now in the American Museum. Its number is 2105. Views of this type, seen from below and from above, and three cross-sections are here presented (Figs. 1 and 2). The specimen consists of the snout from the front of the orbits to the tip of the rostrum, but no other parts. On the lower side the surface of the bone has been damaged, so that the ornamentation is removed over a considerable area; but where preserved, it is not especially different from that of the upper side. It is somewhat coarser, and for a short distance in front of the vomerine fangs forms areolæ resembling those of the shell of *Trionyx*. The specimen has suffered some crushing, and this affects especially the region from the orbits to the vomerine fangs, but also to some extent nearly the whole length of the rostrum.

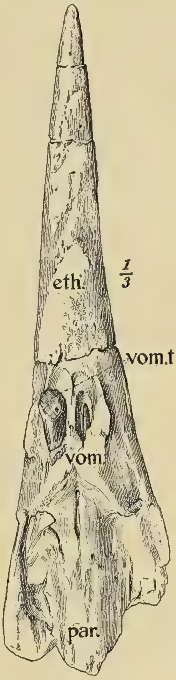


Fig. 1. *Protosphyræna nitida* (Cope). No. 2105. Type of *Erisichthe penetrans* Cope. Rostrum seen from below. × ⅓. *eth.*, ethmoid; *par.*, parasphenoid; *vom.*, vomer; *vom. t.*, vomerine tooth.

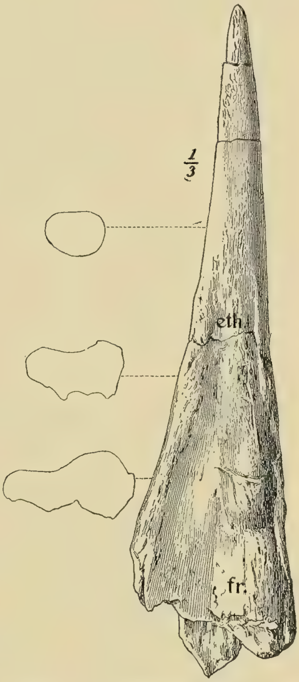


Fig. 2. *Protosphyræna nitida* (Cope). No. 2105. Type of *Erisichthe penetrans* Cope. Seen from above. × ⅓. With cross-sections. *eth.*, ethmoid; *fr.*, frontal bone.

Cope has given the vertical diameter of the base of the rostrum as 20 mm., but this is not correct. The diameter is

24 mm., and was in life probably somewhat more. The same author has also stated that the superior surface of the skull is swollen above the base of the great vomerine tooth, while no such enlargement marks the position of its young companion. This is readily explained. The downward crushing during fossilization has been resisted by the base of the great fang, while on the other side there has been nothing to resist crushing.

The vomerine fang referred to (Fig. 1, *vom. t.*) has an antero-posterior diameter of 17 mm. and a transverse diameter of 8 mm. The crown is mostly missing. It has been directed strongly forward. In the alveolus of the other side is seen the tip of the fang which was to have come into function on the shedding of the large one now present.

In 1890, Felix, as cited, identified correctly, as it appears, and figured a beak as that of *P. penetrans.*

Various other specimens which were collected for Cope in 1877, by Sternberg and Hill, are regarded as belonging to the same species as *P. penetrans* and serve to throw light on its relations to *P. nitida.* One of these, No. 1871, has been less affected by pressure than any others of the collection. The cross-sections of the rostrum are oval, with the transverse axis the longer, until near the insertions of the vomerine fangs, where the two axes are about equal. The ornamentation of the lower side is coarser than that of the upper, but the pattern is the same. In this beak the left vomerine fang is functional, while the right alveolus is a cavity 9 mm. deep. The distance from the fangs to the tip of the rostrum is 125 mm.; the transverse diameter, 27 mm.; the vertical, 26 mm. Halfway from the fangs to the tip the transverse diameter is 18 mm., the vertical, 15 mm.

No. 2121 of this Museum furnishes a complete beak, with the base of the right tooth; the anterior end of the splenial, freed from the dentary; the tip of the left dentary with three large teeth; some other fragments of the jaws and skull; and three sections of the pectoral fin blade, measuring all together 250 mm. The beak is rather slenderer than the type of *P. penetrans* and is smoother near the base. Sections of the

beak are broader than high; but the posterior portion has suffered some distortion. The right vomerine tooth has been functional, but there is hardly a vestige of even the alveolus of the other fang.

Reference must be made here to a species of this genus which has been described by Dr. Loomis (*op. cit.*, p. 225, pl. xx, figs. 1–4) under the name *P. obliquidens*. The beak of this is described as being compressed. The author has figured a portion of the pectoral fin; and this appears to agree in every respect with that of our No. 2121. There is the same front edge, without serrations or undulations; and a band along this edge is represented as being ornamented with fine enamel ridges which run at right angles with the edge. It appears to the present writer that these pectoral fins must be identified as belonging to the same species. Too much importance must not be attributed to the compressed or depressed form of the beak. Many of them have been modified by pressure, and there was probably a good deal of individual variation.

The premaxilla of No. 2121 is missing. The anterior end of the dentary and that of the splenial are well preserved and are figured (Fig. 3). These are attached to the fragment of the fin. Between these bones and the corresponding ones of *P. obliquidens* I find no differences that appear to be important. Dr. Loomis states that his species has three rows of small teeth on the splenial; but in some cases there may be one row on a portion of the splenial and more than one row in another part. The number of rows of these small teeth is probably not a constant character. The small teeth of the dentary are directed forward, as they are in *P.*

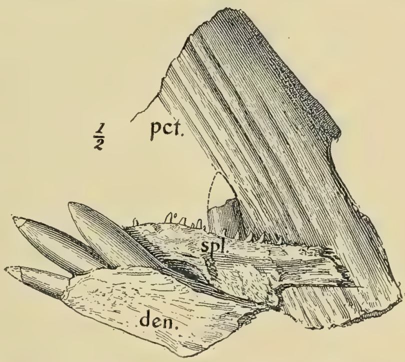


Fig. 3. *Protosphyræna nitida* (Cope). No. 2121. × ½. *den.*, dentary; *pct.*, fragment of pectoral fin; *spl.*, splenial.

obliquidens. The possession of five fangs in the premaxilla, as in *P. obliquidens*, is unusual in *Protosphyræna*, but when we consider that the number of great fang-like teeth in the jaws of *Portheus* varies, we shall not give too great value to this character. In short, it appears to the writer that *P. obliquidens* is identical with *P. penetrans*. Furthermore, it seems impossible to distinguish these two nominal species from Cope's *P. nitida*.

No. 1634 is a part of the Cope Collection, and consists of a considerable part of a crushed skull, with the basal half of the rostrum. The axis of the skull is presented from the vomerine fangs to the basioccipital articulation. A section of the rostrum 52 mm. in front of the vomerine teeth is oval, with the long axis transverse. At the vomerine teeth the section is quadrate, but this is evidently due to lateral pressure. The ornamentation is quite like that of the type of *P. penetrans*, the base of the beak not being so smooth as in No. 2121. Seen from below, it much resembles that of *P. obliquidens.* There is present a part of one of the pectoral fins, presenting about 95 mm. of the edge, and this is identical with that of No. 2121, and, so far as we may judge from the figure, with that of *P. obliquidens*. But the latter has a compressed section; No. 2121, a depressed section. It appears to the writer that the evidence furnished by the fins outweighs that to be derived from the cross-sections of the rostra.

Pelecopterus chirurgus was based on a part of a pectoral fin, with the characteristic front edge broken away. Judging from the part remaining, which comes up close to the edge, and from the angle made by the rays with the edge, there seems little doubt that this fin is identical with *P. obliquidens*, and, therefore, with *P. nitida.* The specimen bears the American Museum of Natural History's number 1894.

Under the name of *Pelecopterus chirurgus* Cope has described (Vert. Cret. Form. West, p. 244E, pl. liv, fig. 9) the articular portion of the shoulder girdle of another specimen. There is no evidence that the latter belongs to the same species as the type of *P. chirurgus;* and the specimen, which is now in the American Museum, No. 1609, cannot be distin-

guished from the corresponding part of *P. perniciosa.* Indeed, this part is probably much the same in all the species.

Impelled by the evidences furnished by the materials before me, I am compelled to regard Cope's *Erisichthe nitida*, *E. penetrans*, and *Pelecopterus chirurgus*, and Loomis's *P. obliquidens* as belonging to a single species, to which the name *Protosphyræna nitida* must be applied.

Protosphyræna perniciosa (*Cope*).

PLATE I, FIG. 1.

Ichthyodectes perniciosus COPE (E. D.), Bull. U. S. Geol. and Geog, Surv. Terrs. I, No. 2, 1874, p. 41; Vert. Cret. Form. West, 1875, p. 275.

Pelecopterus perniciosus COPE (E. D.), Vert. Cret. Form. West, 1875, pp. 244D, 273, pl. xlviii, fig. 2; pl. lii, fig. 2.

Protosphyræna perniciosa WOODWARD (A. S.), Cat. Foss. Fishes Brit. Mus. III, 1895, p. 414. — ? LOOMIS (F. B.), Palæontogr. XLVI, 1900, p. 221, text fig. 2. — HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

This species was established in 1874, as cited, on a fragment of a fin which was afterwards figured on Plate lii of Cope's 'Vertebrata of the Cretaceous Formations of the West.' In this work there were figured also two other fragments of fins which were referred to this species. Of these the one which furnished Fig. 2 of Plate xlviii quite certainly belongs to *P. perniciosa;* the one which is represented by Fig. 13, Plate xliv, appears to belong with those fins which have been referred to *P. tenuis*. It will be observed that the undulations of the edge of this specimen, instead of increasing in height from the base toward the tip, seem to be subsiding.

In the Cope Collection of fishes and reptiles are fragments of several pectoral fins of *P. perniciosa;* but one specimen is especially worthy of description and illustration. This bears the Museum's number 1901. The record accompanying the specimen shows that it was collected by Mr. R. Hill, in 1877, in the Niobrara beds along the South Fork of Solomon River, Kansas. The shoulder girdle accompanies the fin.

The present length of the fin blade (Pl. I, Fig. 1) is 838 mm., but it has doubtless been originally somewhat longer. It is

curved saber-like, and the greater part of the front edge is provided with coarse serrations. From the posterior border some rays are probably missing, and a few of those present have been floated away somewhat from the body of the fin. A count of the rays at the base of the fin shows the presence of 45. Even the most posterior of these may be traced to near the anterior border of the fin at the distal end. As in the specimen of *P. tenuis*, described in this paper, there must have been a posterior fringe of soft flexible rays.

The breadth of the base of the fin is about 105 mm. Here the rays midway between the two borders are very slender, the exposed edges of four of them occupying only 5 mm.; but they grow broader toward their distal ends, so that the four referred to occupy a breadth of 22 mm. Near the distal ends of those rays which outcrop in the anterior border of the fin, at the middle of its length, we find signs of a separation of each into two portions, as in *P. tenuis*. In the distal end of the fin the two components are as distinctly separated from each other as they are from the components of contiguous fins. The thickness of the fin at the middle is 9 mm. As in the case of the fin rays of fishes in general, each ray is composed of an upper and a lower half. At the base of the fin these become broader perpendicularly to the surface of the fin, so as to form plates. Finally these diverge, so as to receive between them the baseosts. Near the anterior border of the base there is a large acetabular cavity for the reception of the rounded head of the scapula.

The tooth-like projections on the front of the fin vary in distance apart from 10 to 15 millimeters. Those of the most distal half of the fin protrude beyond their bases as much as 5 mm. and are retrorse; those of the proximal half are shorter and are dentate in form. In the proximal half of the anterior border there is a tooth at the end of each fin ray; in the distal half, a tooth for each of the two subdivisions of the ray. From the tip of each tooth a rounded ridge runs backward on the surface of the fin at right angles with the course of the rays. This appears to be for the purpose of strengthening the tooth. Each ridge soon divides into two diverging

smaller ridges and at length disappears. Those of the distal portion of the fin may be traced nearly across the fin.

A considerable part of the shoulder girdle of the fin above described is present (Figs. 4, 5), and it enables me to make some corrections in Cope's account of this part of the anatomy (Vert. Cret. Form. West, p. 244A). This author affirmed that all the basilar bones, which support the fin, articulated with the scapula; and on this character he founded the order Actinochiri.

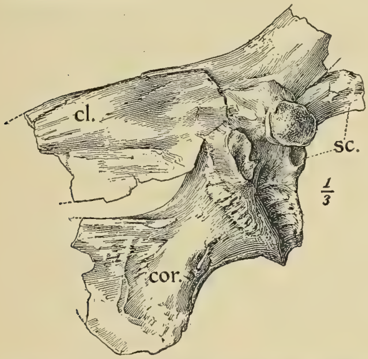


Fig. 4. *Protosphyræna perniciosa* (Cope). No. 1901. × ⅓. *cl.*, cleithrum; *cor.*, coracoid; *sc.*, scapula.

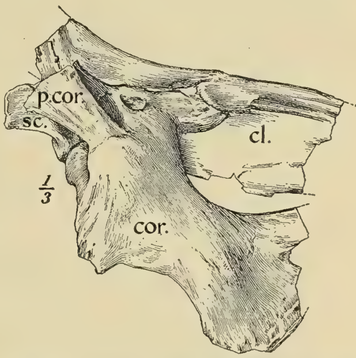


Fig. 5. *Protosphyræna perniciosa* (Cope). No. 1901. × ⅓. *cl.*, cleithrum; *cor.*, coracoid; *p. cor.*, precoracoid.

The conclusion reached by Cope is obviously erroneous; for it is certain that the greater portion of the bone which he identified as the scapula is the coracoid; while the bone supposed by him to be the coracoid is the precoracoid. The result of his erroneous determinations was that he had the shoulder girdle turned wrong end up. All this is satisfactorily proved by comparing these bones with the corresponding ones of *Tarpon* or *Salmo*. Unfortunately, most of the sutures in this complex of bones are obsolete, and Cope himself was unable to make them out in his specimens. At the base of the precoracoid of No. 1901 there is a dislocation of the latter which may indicate the position of the suture. In the tarpon the enlarged anterior fin ray and two baseosts articulate with the scapula. In the specimens of *Protosphyræna* there are no satisfactory indications of the suture that once existed between the scapula and coracoid.

The scapula (Figs. 4, 5, *sc.*) is applied to the inner side of the cleithrum, while the precoracoid, *p. cor.*, appears to be applied to the inner side of the scapula. There may, however, be some distortion here. In *Tarpon* the precoracoid is applied to the inside of the cleithrum in front of the scapula, but it also articulates with the latter.

On the united scapula and coracoid are borne the surfaces for articulation with the fin and its supports. Nearest the cleithrum there is a rounded head (Fig. 4), which fits into a cavity at the base of the fin. Beyond this are two surfaces for the paired baseosts which Cope mentions; and still further out is a row of six grooves for the reception of six unpaired baseosts. Between this shoulder girdle and that of *Tarpon* I see no important differences, except in the presence of the paired baseosts. Of these the outer one corresponds, no doubt, to the articulatory surface for the first baseost of *Tarpon.* For the other, situated below the rounded head on the scapula and mesiad of the surfaces for the other baseosts, I find no equivalent in *Tarpon.* Possibly we must credit to *Protosphyræna* the possession of eight baseosts. Of these the first has possibly been crowded out of its place to a position below the rounded head on the scapula, while the second has been crowded to a position above the head.

The disposition of the paired baseosts with reference to the rounded head and the row of unpaired baseosts must limit greatly the movements of the fin. In fishes there is generally a free movement of the fin at right angles to its plane; but it seems that in *Protosphyræna* there could have been only very restricted motion perpendicular to the plane of the fin. The action of the paired baseosts would have had the effect of steadying the motion in the plane. Such motion would have had as its end the employment of the fin as a weapon, with which its possessor could slash an enemy or a victim of its appetite. The position of the paired and the unpaired baseosts may be determined from Cope's figures (Vert. Cret. Form. West, pl. liv, fig. 9), from the figures already cited of the present paper, and from Fig. 6. In the latter figure the

front border of the fin is above, and the upper (*bas.*) rests on one of the paired baseosts.

No. 2009 of this Museum furnishes both cleithra of *Protosphyræna perniciosa*, which may be conveniently described here. One of these is represented by Fig. 7. It is possible that a small part of the bone is missing from the upper end of the element. Compared with a specimen of *Tarpon atlanticus*, 5 feet 6 inches long (1.67 m.), the cleithrum is narrower. The portion below the curve is of the same length, but the upper end of that of *Protosphyræna* is about 50 mm. shorter. How much of this deficiency is due to injury cannot be determined. The outside of the cleithrum presents no features worthy of mention; the surface probably

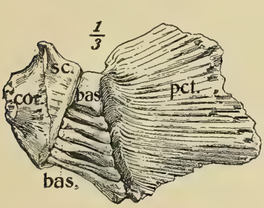
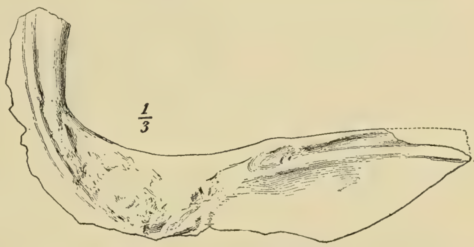


Fig. 6. *Protosphyræna* sp. No. 1646. × ⅓. *bas.*, baseosts; *cor.*, coracoid; *pct.*, pectoral fin; *sc.*, scapula.



No. 7. *Protosphyræna perniciosa* (Cope). No. 2009. × ⅓. Cleithrum seen from inner surface.

has been convex in cross-section. On the inside we see, near the upper border of the lower, or anterior, end, a deep groove which is bounded both above and below by a sharp ridge. On the hinder border of the upper, or posterior, portion there is another groove. This appears to have started at the upper end of the bone and to have run downward as far as the articulation of the fin. It is possible that, as in *Tarpon*, some accessory bone fitted in this groove.

It is remarkable that, although this is perhaps the commonest species of *Protosphyræna*, except perhaps *P. nitida*, it is represented by remains of fins and shoulder girdle bones alone. None of these have been found in association with remains of the head. It appears to be possible that *P. tenuis* Loomis and *P. perniciosa* are identical. The fins appear to differ only in the character of the anterior edge, the angle

which the rays make with the anterior border being the same in both species. Under *P. tenuis* mention is made of fins whose edges are not repand, but have the summits of the waves sharp. No. 2044 is a specimen which is evidently to be referred to *P. perniciosa*, since it has the serrations well developed on many parts of the edge. And yet, well out toward the distal end these serrations subside and the edge is nearly straight. It seems possible that there was considerable variation in the degree of development of the serrations in different individuals. Only more and better materials will enable us to settle this point.

Protosphyræna tenuis *Loomis.*

Plate I, Figs. 2 and 3.

Pelecopterus perniciosus Cope (E. D.), Vert. Cret. Form. West, 1875, pl. xliv, fig. 13 (erroneous identification).

Protosphyræna tenuis Loomis (F. B.), Palæontogr. XLVI, 1900, p. 226, pl. xx, figs. 5–7.—Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

Protosphyræna penetrans Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, pp. 370, 402, pl. lxiii, figs. 1–3.

This species is said to be based on three individuals which were collected by Mr. C. H. Sternberg in the Niobrara deposits of Kansas and are now in the Museum at Munich, Germany. The parts figured belong to one individual and consist of a rostrum, premaxilla and maxilla of the left side, and a part of one pectoral fin. This appears to be a well founded species. The rostrum is, relatively to the length of the maxilla, very long and slender. The maxilla enters into the length of the rostrum two times, while in a specimen of *P. nitida* the maxilla is contained in the rostrum only one and a half times. The teeth of the maxilla appear to be smaller than they are in *P. nitida*. The most certain evidence that this species does not belong to *P. nitida* is to be found in the pectoral fin blade. On comparing it with the figure of Dr. Loomis's *P. obliquidens* (= *P. nitida*), figured on the same plate, we find that in the latter the edge of the fin is devoid of any undulations and that the rays make an angle of nearly 10° with the edge; while in *P. tenuis* the edge is

wavy, especially near the base, and the rays make an angle of 15° with the edge. I regard these differences as important.

In the American Museum there are several specimens of fins which I refer to *P. tenuis*. One of these, No. 205 (Pl. I, Fig. 2), is 528 mm. long and is accompanied by a portion of the baseosts and a part of the cleithrum. It presents apparently 36 rays, including the shortest one at the base in front. As a result probably of maceration and some disturbance before burial, some of the hindermost rays are separated from one another, except immediately at the base. It is probable that others of the hindermost have been wholly removed. At its base, as now found, the fin is 62 mm. wide. The front edge is gently repand in the basal half; but in the distal half the edge has a uniform curve. The edge is everywhere thin and sharp, and is strengthened by a layer of enamel, as in the other species. This layer is disposed more or less in ridges at right angles to the edge; but these do not have the regularity and fineness which they present in *P. nitida*. As in other species of the genus, the anterior edge of the fin is formed by the ends of the rays which successively outcrop at their distal ends. All the rays, except a few of the first, become broader as they proceed outward. The greatest increase in width is found in the most posterior rays. At the base they are only about 1.5 mm. in diameter, but distally they may be as much as 5 mm. in diameter. At about the 20th ray we find at its distal end evidences of a division into an anterior and a posterior portion. This separation becomes still more distinct in the succeeding rays. In another specimen, No. 215, traces of the cleft condition may be found as far forward as the 12th ray from the front, and is indicated by a narrow furrow, or line of pits.

In the front of the fin in No. 215 are two holes which are made entirely through the rays, and these, with some fractures, must have been produced before the specimen was covered with the matrix. It is easy to imagine that this fish had been seized and destroyed by some *Portheus* or some mosasaur.

The fins of this species resemble those of *P. perniciosa* in the angle which the rays make with the edge of the fin. As

in the latter species, the base of the fin is undulated for a few centimeters, but beyond this the character of the edge in the two species is very different. In *P. tenuis* the undulations subside and the edge is continuous; in *P. perniciosa*, the elevations increase in height and soon take the form of hooked teeth.

No. 1620 of this Museum, a part of the Cope Collection, probably belongs to this species. It appears to differ only in having the edge resemble a series of waves whose summits are not rounded but sharp (like Figs. 1, 2, Pl. lxiii, of Stewart's memoir) and in having them continued well out toward the distal end of the fin. Such fins possibly belong to a distinct species. This specimen displays the distal end of the fin apparently to within a few centimeters of the tip (Pl. I, Fig. 3). Behind the rays which are consolidated together are several others which evidently have been only loosely connected and which have been subdivided into very fine filaments. Evidently, too, the hindermost of these loose rays did not reach quite to the tip of the fin. It is quite probable, therefore, that a considerable number of soft flexible rays occupied the hinder border of these remarkable fins. No cross-segmentation of these rays can be observed. As stated under *P. perniciosa*, there is some reason to doubt that *P. tenuis* is distinct from the species just mentioned.

Protosphyræna dimidiata (*Cope*).

Erisichthe nitida Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. III, 1877, p. 822.

Protosphyræna nitida Loomis (F. B.), Palæontogr. XLVI, 1900, p. 227 (in part), pl. xix, figs. 6, 7.

Erisichthe dimidiata Cope (E. D.), Proc. Amer. Assoc. Adv. Sci. XXVI, 1878, p. 300.

Protosphyræna dimidiata Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

This species, the type of which is now in the American Museum of Natural History, having the number 1635, was originally described as belonging to *Erisichthe nitida*. However, within the next year, Prof. Cope came to the conclusion

that it represented a distinct species and to this he gave the name *Erisichthe dimidiata* (Proc. Amer. Assoc. Adv. Sci., XXVI, 1878, p. 300). Of this change of opinion and this new name neither Felix, writing in 1890, nor Loomis, writing in 1900, was apprised.

The most obvious characters of the species are those presented by Cope in his original description, the upward curvature of the rostrum and the flattening of the upper surface of its distal half. Felix, having before him a specimen which he regarded as belonging to the same species, denies the presence of the angular ridges on the sides of the rostrum. They are present, nevertheless. The rostrum (Fig. 8) has been broken across just in front of the vomerine fangs and a portion of the upper surface has crumbled away, perhaps for a distance of 25 mm.; but there is little or nothing missing on the lower side. About 22 mm. in front of this break there has been another break and a slight faulting in the bone. From this point there is a gradual upward curve to the tip of the beak. Just in front of the last-mentioned break the vertical diameter is 23 mm., the transverse, 26 mm., the section being oval. Halfway to the tip, the upper surface has become decidedly flat, the vertical diameter being 16 mm., the transverse, 22 mm. Beyond this section the upper surface is somewhat concave, with a sharp ridge bounding the concavity on each side. Near the tip the upper surface again becomes convex. Both the upward curvature of the beak and the concavity of the upper surface appear to be wholly natural.

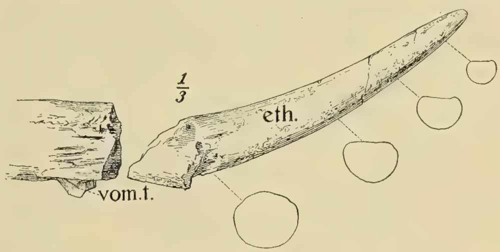


Fig. 8. *Protosphyræna dimidiata* (Cope). No. 1635. × ⅓. Type of *Erisichthe dimidiata* Cope. Rostrum seen from the side, with four cross-sections. *eth.*, ethmoid; *vom. t.*, vomerine teeth.

There appears to be less difference in the sculpture of the upper and lower sides than in the case of *P. nitida*.

The premaxilla (Fig. 9, *pmx.*) possessed four fangs. Its length has been about 75 mm.; the elevation of the hinder end about 43 mm. The maxilla (Fig. 9, *mx.*) is 137 mm. long, with a depth of only 17 mm. where narrowest, then again expanding to near 30 mm. Another bone, probably a jugal, has overlapped the hinder end of the maxilla on the upper side. There is space for about 33 teeth on the maxilla. They are lancet-shaped and are not so strongly inclined forward as they are in *P. nitida.* The same is true of the teeth of the mandible. Outside of the row of cutting teeth is a row of much smaller teeth.

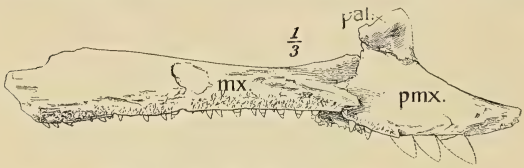


Fig. 9. *Protosphyræna dimidiata* (Cope). No. 1635. × ⅓. Type of *Erisichthe dimidiata* Cope. Upper jaw, side view. *mx.*, maxilla; *pal.*, portion of palatine; *pmx.*, premaxilla.

The lower jaws are represented by 68 mm. of the anterior end of the left mandible and by nearly the whole length of the right. The tip of the latter and a section of about 30 mm. are wanting, as well as most of the lower border of the bone. In the anterior end of the dentary we find the usual three lancet-shaped fangs. These are succeeded by an interval in which the teeth are very small or wanting. Then follows a single row of cutting teeth, of which those in front and those behind are small. The presplenial is occupied, as in the other species, by two strong fangs. Laterad of these and running nearly the full length of the presplenial is a band of small teeth. This consists of three rows where narrowest. A short distance behind the posterior presplenial fang the band of small teeth is interrupted by what may be a suture between the presplenial and the postsplenial. It is not unlikely, however, that it is only a fracture, since the whole jaw has suffered flexure at this point. In specimens of *P. nitida* no suture can be seen; although at this point the band of teeth becomes very narrow and thereafter widens rapidly. Felix was unable to find a suture between the supposed two bones. If they have ever been distinct at any time of the

animal's life, they are now probably consolidated. The "predentary" of Felix was evidently the result of erroneous observation.

Lying against the inner surface of the posterior end of the premaxilla (Fig. 10) is a bone whose edge bears a band of three rows of teeth which resemble those of the presplenial, some being two-edged, but most of them conical. This bone, now 30 mm. long, but with its anterior and posterior ends missing, I take to be the palatine. Lying against the median surface of the anterior end of this palatine and extending forward nearly to the anterior end of the premaxilla is another bone which bears a large patch of granular teeth. It is possibly a part of the palatine.

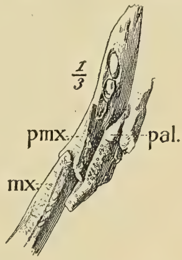


Fig. 10. *Protosphyræna dimidiata* (Cope). No. 1635. × ⅓. Type of *Erisichthe dimidiata* Cope. Part of upper jaw from below. *mx.*, anterior end of maxilla; *pal.*, portion of palatine; *pmx.*, premaxilla.

The writer sees little reason to doubt that the specimens referred to *P. nitida* by Dr. Loomis, and figured on Plate xix, Figs. 6, 7, of his paper here frequently quoted, really belong to *P. dimidiata*. There is the same narrow maxilla; but, especially, the dentary teeth are only slightly inclined forward.

Among the remains belonging to the type of *P. dimidiata* there is present a single vertebra, apparently one belonging close to the head. It is possible that this is an intrusion, either at the time of burial or after collection; but the matrix is the same and the bone is similarly fossilized. The vertebra is represented in Figs. 11 and 12. It is 12 mm. long and 19 mm. in the transverse and vertical diameters. The ends (Fig. 11) are deeply cupped. The arches have dropped away, not having been coössified. The lower surface (Fig. 12) is ornamented with a network of low ridges. The verte-

Fig. 11. ? *Protosphyræna dimidiata* (Cope). No. 1635. × ½. Part ? of type of *Erisichthe dimidiata* Cope. Vertebra, view of anterior end.

Fig. 12. ? *Protosphyræna dimidiata* (Cope). No. 1635. × ½. Part ? of type of *Erisichthe dimidiata* Cope. Vertebra, view of lower surface.

bra agrees in size with the basioccipital of some skulls of *Protosphyræna.* It is possible that it belongs to either *Pachyrhizodus* or *Anogmius*, but it appears to be different. Cope believed (Proc. Amer. Assoc. Adv. Sci., XXVI, 1878, p. 299) that this genus possessed well developed vertebræ, but whether or not he based his opinion on this particular vertebra is not known. It is very desirable that collectors shall give attention to the finding of such parts of the body of the fishes of this genus as have not yet been described; and such parts include practically all parts behind the shoulder girdle and pectoral fins.

Protosphyræna sequax, sp. nov.

Protosphyræna nitida Felix (J.), Zeitschr. deutsch. geol. Gesellsch. XLII, 1890, p. 278, pl. xii, figs. 1–3; pl. xiii, figs. 1–2b; pl. xiv, figs. 2–7.—Loomis (F. B.), Palæontogr. XLVI, 1900, p. 227 (in part).—Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379 (in part).

Dr. Loomis has already concluded that, on account of the position of the teeth of the dentary bone, Felix's specimen does not belong to the same species as the dentary figured by Cope as part of *P. nitida;* but Loomis's explanation is that Cope's dentary does not belong with the premaxillary, and is, therefore, not a part of *P. nitida*, an idea already suggested by Felix (*op. cit.*). As elsewhere remarked, there is no reason for questioning the unity of Cope's type. The more reasonable explanation is that Felix's specimen does not belong to Cope's species, *P. nitida.* And one of the grounds for this conclusion is found in the fact that the teeth of the maxillæ and those of the dentary, except the three anterior fangs, are, in Felix's specimen, inserted at nearly right angles to the containing bones. Even those of the premaxillæ emerge nearly perpendicular to the border of the latter bone.

Nor can Felix's specimen belong to *P. dimidiata.* The posterior teeth of the maxilla of the type of the latter have a decided slant forward. The median and anterior teeth are nearly perpendicular. All the teeth of the premaxilla appear

to have inclined forward. The cutting teeth of the middle of the dentary are only slightly inclined forward, not greatly different from the corresponding ones of the skull described by Felix. The maxilla of the latter is quite different from that of *P. dimidiata* and that of *P. nitida*, as represented by the specimens described under that species. In the type of *P. dimidiata* the maxilla has a length of 137 mm., a width where widest of 17 mm. and where broadest, near the hinder extremity, of 30 mm. The maxilla of Felix's specimen is probably little, if any, longer. The figure gives evidence that little of that of the left side is missing. Its width, where narrowest, is 20 mm.; where widest, at least 32 mm. Of the right maxilla of Felix's specimen perhaps nothing is wanting and it measures only 130 mm. This indicates that the bone was of considerably heavier construction than in *P. dimidiata*. If it be contended that the maxilla of Felix's individual belongs to a larger animal and was both longer and broader, it may be shown that it must have contained a considerably larger number of teeth. On measuring backward from a point 25 mm. behind the anterior end of the maxilla of *P. dimidiata*, there are found 9 teeth or alveoli for them, in 32 mm. In the same distance on the left maxilla of Felix's specimen are 9 or 10 teeth, or spaces for them. This indicates either that the maxilla was no longer or that the teeth were relatively smaller. Indeed, in the portion of the left maxilla represented by Felix, 103 mm. long, there is room for as many of its teeth as are found in the 122 mm. of tooth line of *P. dimidiata*. Furthermore, the rostrum of the specimen described by Felix is very different from that described by Cope, as Felix himself has pointed out.

Protosphyræna sequax differs from the specimens which are here referred to *P. nitida* in most of the respects in which it differs from *P. dimidiata*, viz., in having teeth perpendicular, or nearly so, to the supporting bones and in having a broad heavy maxilla.

It is, of course, impossible to say that the skull here described does not belong to some species which has already received a name based on a fin blade. It may, for example,

be the skull of *P. perniciosa.* In such case *P. sequax* will become a synonym.

Protosphyræna ziphioides (*Cope*).

Erisichthe ziphioides (Cope E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. III, 1877, p. 823.

Protosphyræna ziphioides Newton (E. T.), Quart. Jour. Geol. Soc. XXXIV, 1878, p. 795. — Felix (J.), Zeitschr. deutsch. geol. Gesellsch. XLII, 1890, p. 297. — Woodward (A. S.), Cat. Foss. Fishes Brit. Mus. 1895, p. 413. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 379.

Erisichthe xiphioides Loomis (F. B.), Palæontogr. XLVI, 1900, p. 222.

This species was described by Cope in 1877, as above cited. The description was quoted by Felix and accompanied with brief remarks. The type specimen is now in the American Museum of Natural History, and has the number 2131. Cope states that the specimen is the muzzle of an old individual which has lost a good deal of its apex by attrition. It is probable that he meant that this attrition had been suffered during the life of the animal. The present writer, however, finds no evidences of any attrition. It appears improbable that the beak could have been worn to any considerable amount without revealing it either in the character of the surface or in some asymmetry. Where the wear must have been suffered, the bone is dense and smooth and the form wholly symmetrical. The specimen appears to have belonged to a species having a short and blunt snout.

The following measurements are given.:

Length of the specimen	102 mm.
Width of the hinder end	30 mm.
Transverse diameter at vomerine alveoli	22 mm.
Vertical " " " "	19 mm.
Transverse " 15 mm. from tip of snout	20 mm.
Vertical " " " " " "	14 mm.

On the under side of the snout (Fig. 13, *vom. t.*) is a pair of longitudinal depressions. These Cope regarded as alveoli for vomerine fangs, from which the teeth had fallen and which

had become filled up with bone. His explanation is probably the correct one. At the hinder end of the specimen, on the under side, is a triangular depression. This appears to be produced by the parting of the hinder ends of the vomers, so as to expose the parasphenoid (Fig. 13, *par.*); but the bones are somewhat eroded. The apex of this depression is considerably farther behind the alveoli of the vomerine fangs than in any other described species of the genus, being about 25 mm.; while in the type of *P. penetrans* the interval is only 15 mm.

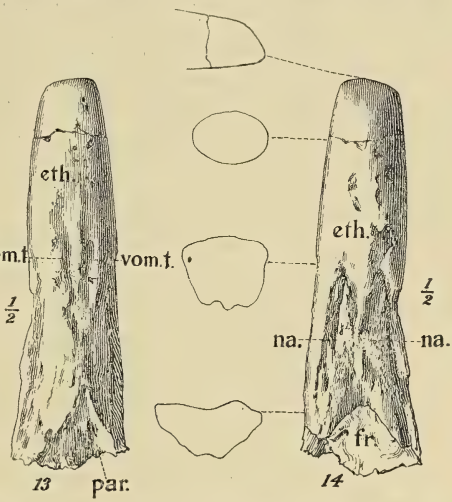


Fig. 13. *Protosphyræna ziphioides* (Cope). No. 2131. × ½. Type of *Erisichthe ziphioides* Cope, seen from below. *eth.*, ethmoid; *par.*, parasphenoid; *vom. t.*, position of vomerine teeth.

Fig. 14. Same rostrum as Fig. 13, viewed from above, with three cross-sections and a longitudinal section of tip. *eth.*, ethmoid; *fr.*, frontal; *na.*, nasals.

On each side of the basal half of the specimen and extending forward to a line crossing just in front of the vomerine alveoli is a longitudinal excavation. Cope regarded these as probably intended for the reception of the forward prolongations of the premaxillæ. It is more probable that they receive the anterior ends of those bones which Felix has called "ethmoidea lateralia." There is some reason to think that a portion of these bones is yet in these excavations. Possibly if the whole of these lateral ethmoids were present the lower surface of the beak would not be so constricted as it is.

The hinder end of the upper surface is occupied by a triangular smooth depression (Fig. 14, *fr.*). The writer takes this to mark the anterior termination of the frontals, united into one bone. In front of this depression the surface is rough, as if from erosion. On each side of this rough area

there is a moderate longitudinal excavation, which appears to be partially filled by the remains of a distinct bone (Fig. 14, *na.*). These two bones appear to have overlapped the anterior ends of the frontals and to have met in the midline. They are probably the nasals.

The supposed nasals on the upper side and the supposed "lateral ethmoids" on the lower side are separated by right and left ridges of bone which evidently form a part of the ethmoid. These are continued forward to the tip of the beak and form the boundary lines which separate the convex lower surface of the beak from the flatter upper surface. As these ridges pass forward they descend on the sides of the beak, until at its tip they meet at the level of the lower surface. The convexity of the upper surface increases as we move toward the tip of the beak and that of the lower surface diminishes, until at length, 15 mm. behind the tip, the upper surface becomes more convex than the lower. In Figure 14 are presented cross-sections of the beak at three points. The outline figure above the sections represents a longitudinal section at the end of the beak.

The specimen was found in the Niobrara deposits of Gove County, Kansas. It seems not unlikely that it represents a distinct genus.

Protosphyræna gladius (*Cope*).

Portheus gladius Cope (E. D.), Proc. Acad. Nat. Sci. Phila. 1873, p. 337; Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1874, p. 40.

Pelecopterus gladius Cope (E. D.), Vert. Cret. Form. West, 1875, pp. 244E, 273, pl. xliv, fig. 12; pl. lii. fig. 3. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 221, text figure 3, tail.

Protosphyræna gladius Hay (O. P.), Bibliog. Cat. Foss. Vert. N. A. 1902, p. 379.

The type of this species is now in the American Museum of Natural History, and bears the number 1849. It measures 728 mm. in length, Prof. Cope's statement making it equal to 31 inches being slightly erroneous. In his description of the specimen Cope says that Prof. Mudge, the collector, re-

ported that the original length was 41 inches. This statement is not at all improbable. The second specimen described by Cope (Vert. Cret. Form. West, p. 244F, pl. xliv, fig. 12) is also in the Museum's collection and is numbered 2064.

The type fin blade has been somewhat distorted by pressure, so that the surface, instead of being flat, as it undoubtedly was originally, is, as Cope says, trough-like. That the surface was flat is shown by other specimens in the collection which were obtained for Cope by Sternberg and Hill. The enamelled edge is sharp, sharper than the edge of the regulation table knife. The edge is not straight, but has the appearance of having been nicked here and there, as is shown by Cope's figure. This author thought that these irregularities had been produced by the rough uses which the fish had made of the fin; but, since the bottoms of the notches are as sharp as the edge elsewhere, it is not probable that there have been any injuries done to the edge.

At the base of the fin the anterior rays have been so thoroughly consolidated that they cannot be counted; but, after making proper allowances, there appear to be about 50 rays entering into the portion of the fin represented by the specimen. The rays, beyond the most anterior ones at the base, grow wider as they are followed toward the distal end; where, one after the other, they emerge at the anterior border, becoming consolidated with those in contact with them. Those which reach the distal half of the fin become divided each into an anterior and a posterior portion, as in the case of *P. perniciosa.*

In the case that the fin was originally about 1040 mm. long, that is about 312 mm. longer than it is now, there must have been about 13 more spines entering into its construction, that is 63 altogether; for the last 312 mm. of the length is now occupied by 26 outcropping ends, and these represent 13 rays at the base. If this estimate is correct, the fin must have been about 200 mm. wide at the base.

For the greater part of its length the fin is 20 mm. thick, measured at a distance of 50 mm. behind the edge. Near the base the thickness is still greater. Other specimens in the

collection show that the front border is bevelled off on both sides, as a board may be bevelled off by a carpenter's plane.

At the middle of the length of the fin the component rays make an angle of about 22° with the edge. At the distal end the angle is somewhat smaller.

This fin must have belonged to a large and powerful fish, of which no other parts are known.

Dr. Loomis in his paper on Kansas fishes holds that this fin formed one lobe of the caudal fin of some species of *Protosphyræna;* and in his restoration of *Protosphyræna* he reconstructs the caudal fin from this specimen. This is, however, manifestly an error. In the caudal fin of fishes the right and left halves of the constituent rays diverge slightly at their proximal ends, so as to receive between them the hypural bones. They are also each drawn out to a point. In the pectoral fins the two portions of the ray not only diverge strongly, but each half is broadened so as to form two processes. One of these is directed toward the corresponding surface of the fin, while the other is brought into close contact with the small bones at the distal ends of the baseosts. The fin known as *Protosphyræna gladius* has the same structure as that of the pectoral fin of ordinary fishes and of other species of *Protosphyræna.*

PLETHODIDÆ.

Anogmius *Cope.*

This genus was erected by Prof. Cope in 1871 (Proc. Amer. Philos. Soc., XII, p. 170), the type species being *A. contractus*, and the type specimen consisted of a large number of vertebræ representing a fish believed to be about four feet in length. The vertebræ were in the Agricultural College, at Manhattan, Kansas, and had been collected by Prof. B. F. Mudge. These vertebræ are further described on page 354 of the volume referred to. This description is repeated on page 241 of the same author's 'Vertebrata of the Cretaceous Formations of the West'; but on page 220A, evidently written later, he records his conclusion that the genus in question was really

identical with *Pachyrhizodus*. In 1877 (Bull. U. S. Geol. and Geog. Surv. Terrs., III, p. 584) Prof. Cope again restored his genus *Anogmius* to favor, and described the new species *A. aratus*, based on a nearly complete individual. This permitted him to define more fully the characters of the genus. In the same year he described two additional species, *A. favirostris* and *A. evolutus*, collected for him in Kansas, by Sternberg's party.

Dr. A. S. Woodward (Cat. Foss. Fishes, IV, 1901, p. 71) apparently takes the position that Cope, when he described *Anogmius aratus*, intended to employ the generic name in a new sense, and to make *A. aratus* the type of the new genus. Prof. Cope's language may give some justification to this conclusion; but it is evident that he intended to include the original species, since he cites the original description. He had evidently again changed his mind regarding the generic position of the type vertebræ. The vertebræ of the species assigned to *Anogmius* and those of *Pachyrhizodus* resemble one another closely, and Cope's vacillation is not to be wondered at as long as he possessed no other parts for comparison. But in his second description (Proc. Amer. Philos. Soc., XII, p. 354) he mentions characters which appear to separate the two genera. One of these is found in the crowded condition of the vertebræ at the base of the caudal fin of *Anogmius*; the other, in the failure of the upper and lower arches in this region to become coössified with their centra. Figures 15 and 16 of this paper represent the condition of this part of the vertebral column. In *Pachyrhizodus* there is apparently less crowding of the vertebræ, and the arches become coössified with the centra. On this point see Dr. Loomis's figure (*op. cit.*, pl. xxvi, fig. 9). Stewart (Univ. Geol. Surv. Kansas, VI, pl. lxvi) presents a tail of *Anogmius* in which the shortening and crowding are less than in any that I have seen.

1/2

Fig. 15. *Anogmius* sp., No. 1616. × ½. Caudal vertebræ.

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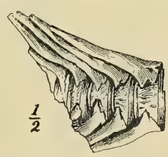


Fig. 16. *Anogmius* sp., No. 1116. × ½. Caudal vertebræ.

Just what Cope's *Anogmius contractus* was we shall probably never know. Prof. E. A. Popenoe, who has charge of the collection of the Agricultural College at Manhattan, Kansas, informs me that he is unable to find any traces of such vertebræ as Cope described. The type being lost, it seems proper to accept Cope's *Anogmius* on the definition given of it. When it becomes necessary to divide the genus as thus defined, it will be time to consider whether or not *Anogmius* is indeterminable.

Recently Dr. Loomis (*op. cit.*, p. 254) has made Cope's *Anogmius* (spelled, however, *Agnomius*) a synonym of *Osmeroides* Agassiz. Mr. Woodward properly, as it seems to me, does not follow this identification. So far as we know, the species of *Anogmius* have an elongated dorsal fin, while *Osmeroides* (*Holcolepis*) has a short dorsal. There exist undoubtedly many other distinctive characters.

Dr. Loomis (*op. cit.*, pp. 229, 235, 252) has described the new genera *Thryptodus*, *Pseudothryptodus*, and *Syntegmodus*. Stewart in his work referred to, p. 391, has expressed the opinion that the first two genera mentioned are synonymous with *Anogmius*. Dr. A. S. Woodward (Cat. Foss. Fishes, IV, pp. 84, 85) regards all three as closely related to *Plethodus*.

There are so many structures common to the genera *Plethodus*, *Anogmius*, *Thryptodus*, *Pseudothryptodus*, and *Syntegmodus*, that it appears evident that they are all closely related, and some of them are quite certainly identical with others. All appear to have an upper grinding plate developed on the parasphenoid and one or more lower plates developed on the median bones in the floor of the mouth. These plates are composed apparently of dense bone, and are often, if not always, furnished with pits, sometimes shallow, sometimes deep. The maxilla forms a considerable part of the boundary of the mouth, the bones about the mouth are similarly sculptured, and, so far as we know, the rear of the skull is similar in all.

Plethodus appears to be characterized by coössification of the premaxillæ and ethmoid and the possession of a lower dental plate composed of a single bone. The upper and lower plates are smooth or furnished with shallow pits.

Anogmius, as represented by *A. aratus* and *A. favirostris*, described on succeeding pages, has the premaxillæ free from the ethmoid, and possibly from each other, and the dental plates are deeply pitted. The lower plate is composed of two and possibly of three median bones.

Syntegmodus is described as having the parasphenoid and some other bones of the mouth covered with a thick mass of osteodentine. This is penetrated by large canals which pass from the surface to the bone on which the supposed osteodentine mass rests. This mass is probably composed of dense bone. On comparing Dr. Loomis's *Syntegmodus*, and the known remains of *A. aratus* and *A. favirostris* and a specimen resembling *Syntegmodus altus*, among one another, it is difficult to see how they may be distinguished generically.

Thryptodus is regarded by Dr. Loomis as having the premaxillæ not free, but probably consolidated with the ethmoid. The parasphenoid has developed a great oval, concave, dental plate, which is furnished with pits; while the median bones of the floor of the mouth support plates which work against the parasphenoidal plate. A study of the type of Cope's *Anogmius aratus*, figures of which are presented in this paper, have convinced me that the relation of the premaxillæ to the ethmoid has been misunderstood by both Prof. Cope and Dr. Loomis, and that *Thryptodus* is identical with the type of *Anogmius aratus*. In this form, as illustrated by the types of *A. aratus* and *Thryptodus*, the premaxillæ appear to be united, while in *A. favirostris* they are possibly, but not certainly, free from each other. If this difference is confirmed by other specimens it may require that two genera shall be recognized; but for the present it seems to the author best to unite all under *Anogmius*. *Pseudothryptodus*, with free premaxillæ, will be included.

Reference has already been made to the differences supposed to exist between the vertebræ of *Pachyrhizodus* and *Anogmius*. However much they may resemble, there is great difference in the structure of the tails of the two genera. There is apparently little difference in the form of the tail fins, both being deeply forked. In *Pachyrhizodus*, as shown

by Pl. III, Figs. 1 and 2, the rays constituting each lobe are comparatively few, and these are large, and cross-segmented. In *Anogmius*, on the other hand, the rays (Fig. 17, a fragment of the caudal fin) appear to have been in greater number and to have shown no segmentation, unless this may have appeared toward the distal ends. It will likewise probably prove true that in *Pachyrhizodus* the neural and hæmal arches of the caudal region are always consolidated with the centra, while in *Anogmius* they remain distinct.

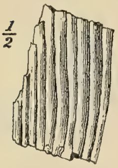


Fig. 17. *Anogmius* sp. No. 2055. × ½. Fragment of caudal fin.

Anogmius favirostris (*Cope*).

Anogmius favirostris Cope (E. D.), Proc. Amer. Philos. Soc. XVII, 1877, p. 178.—Woodward (A. S.), Cat. Foss. Fishes Brit. Mus. IV, 1901, p. 73.—Hay (O. P.), Bibliog. Cat. Foss. Vert. N. A. 1902, p. 393.

Osmeroides favirostris Loomis (F. B.), Palæontogr. XLVI, 1900, p. 256.

This species was based on the skulls of two individuals, one of them accompanied by a number of vertebræ. These specimens are now in the American Museum of Natural History, but they appear to be somewhat less complete than when they were described by Prof. Cope. One of them, No. 2111, which must be regarded as the type, since from it the description was mostly drawn, consists of the rear of the skull and some fragments of its upper surface, the premaxillæ and maxillæ, the anterior portions of both dentaries, the anterior half of the left palatine and the whole of the right, and a considerable part of the parasphenoid. With these skull parts are 11 vertebræ.

The rear of the skull shows that the parietals are broadly joined. Behind these is a narrow area occupied by the supraoccipital and the epiotics, but the exact extent of these cannot be determined. The midline of the rear of the skull is occupied by a valley, deepest and widest between the parietals, where its width is about 10 mm.

Figure 18 presents a view of the front of the head, seen

from below. The outer surface of the right dentary is observed; also the tooth-bearing and triturating surfaces of the premaxillæ, the maxillæ, the palatines, the vomer, and the parasphenoid. The premaxillæ are sculptured with grooves superiorly and with pits nearer the tooth line. Here we find a band of 5 or 6 rows of small teeth. The outer rows of teeth become very small and some of them are found standing on the narrow walls surrounding the pits. A similar band is found on each maxilla, and on each of the dentaries. What I regard as the parasphenoid Cope has described as the vomer. It is, however, too elongated; and besides, it seems to correspond with what is certainly the parasphenoid in other specimens of the genus figured in this paper. Moreover, there is a patch of teeth farther forward which is supposed to belong to the vomer. Cope has spoken of this parasphenoid as if it were covered with small teeth. I find traces of teeth around its border and a considerable patch in front; elsewhere, the bone is occupied by pits and is devoid of teeth. Where the teeth are very small, they occupy the summit of the bone surrounding the pits. This bone, as well as the palatines, is thin, only about 2 mm., but this is probably due to pressure. The pits have the appearance of passing deeply down into the mass of the parasphenoid. The surface of the dentine-like layer of the bone presents evidences of wear. The lower surface of the palatines resembles the surface of the parasphenoid. A few small teeth are to be seen around the borders of the bone. The patches of teeth between the maxilla and palatine

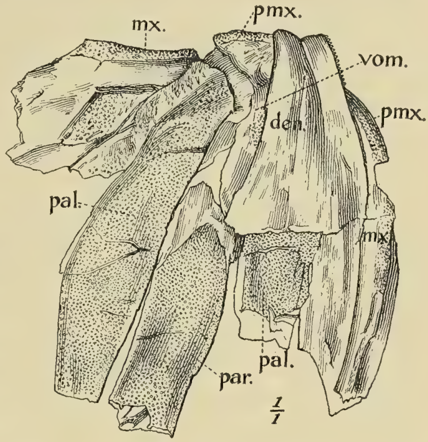


Fig. 18. *Anogmius favirostris* Cope. No. 2111. × ½. Type. *den.*, dentary; *mx.*, maxilla; *pal.*, palatine; *par.*, parasphenoid; *pmx.*, premaxilla; *vom.*, vomer.

in Fig. 18, probably, but not certainly, belong to the palatine.

The hinder end of the parasphenoid is missing; but it is not likely to have been much wider than the part present. The species, therefore, appears to be characterized by a narrow parasphenoid. In one important respect this parasphenoid differs from that of *A. aratus*, figured in this paper. In the latter species the parasphenoid extends forward nearly as far as the palatines do. In *A. favirostris* the parasphenoidal dental plate, at least, falls far short of the anterior end of the palatines. I am not able to see that this is due to displacement.

The vertebræ (Fig. 19) are little constricted, devoid of conspicuous lateral grooves, and provided with fine longitudinal ridges. There appear to be no lateral processes such as are found in some related species.

The paratype of the species, No. 2109, consists of the anterior half of the skull, and is of most interest seen from below (Fig. 20, natural size). The specimen has evidently had pressure applied to the snout, so as to drive it backward against the other bones. The anterior ends of the dentaries overlap. Just behind and

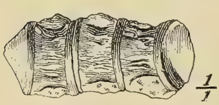


Fig. 19. *Anogmius favirostris* Cope. No. 2111. ×1. Type. Three caudal vertebræ.

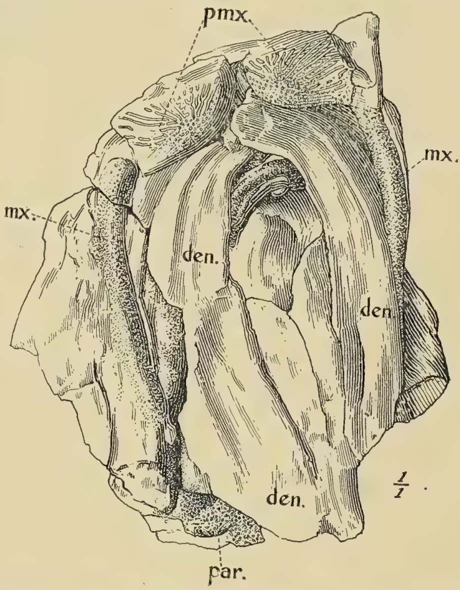


Fig. 20. *Anogmius favirostris* Cope. No. 2109. ×1. Paratype. *den.*, dentary; *mx.*, maxilla; *par.*, parasphenoid; *pmx.*, premaxillæ.

between these overlapping ends are seen the edges of two toothed bones, one in front of the other. Probably the one in front is the vomer, the other possibly a part of the glossohyal.

In front of the symphysis of the dentaries (*den.*) are seen the premaxillæ (*pmx.*) evidently pressed downward and backward. They are ornamented as in the type. As shown in the figure, the maxillæ (*mx.*) join the premaxillæ and form the greater part of the border of the mouth. The lower border is pitted, and some or all of these pits enclosed the bases of teeth. There is also a pitted band on the outer surface of the bone, above the tooth line.

Through a splitting of the specimen a view is afforded of the inside of the mouth. Fig. 21 is a view of the right-hand side of the floor of the mouth seen from above; while Fig. 22 shows the right side of the roof of the mouth turned upside down. If this piece is supposed to be rolled to the left it will fall into its place on Fig. 21, the points marked *a* in the two figures coinciding. Both these figures are of the size of the objects. In Fig. 21 the whole of the surface covered with little rings, which represent pits, except a narrow strip occupying a part of the right-hand side, appears to be made up of one or more dental plates. This is flat along the middle of the figure, but shelves off quite steeply on the right. Near the anterior end is a fold which runs obliquely outward and backward; and there is a similar fold near the hinder end of the dental plate. These folds may be artificial, but they probably represent sutures separating distinct bones. If so, the most anterior one is probably the glossohyal (*gl. h.*); the others

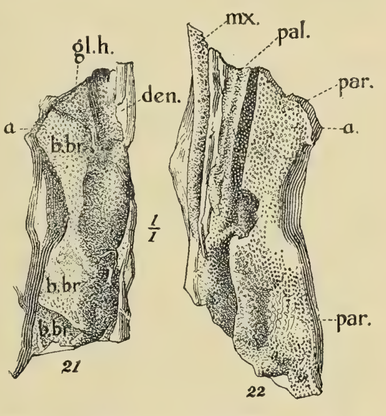


Fig. 21. *Anogmius favirostris* Cope. No. 2109. × 1. Paratype. Floor of mouth, *a*, point coinciding with *a* of Fig. 22; *b. br.*, basibranchials; *den.*, dentary; *gl. h.*, glossohyal.

Fig. 22. Same as Fig. 21. Roof of mouth, *a*, point coinciding with *a* of Fig. 21; *mx.*, maxilla; *pal.*, palatine; *par.*, parasphenoid.

are median bones behind the glossohyal, baso-branchials (*b. br.*). Certainly, the antero-posterior extent of this mass is too great to belong to any one bone in the floor of the mouth.

Along the right-hand border of Fig. 21 are seen the broken edges of the dentary bone and of at least one, perhaps two bones, between the latter and the tritoral surfaces described above. Probably the hyoid and possibly a branchial arch are thus represented.

Fig. 22 presents, on the left-hand side, the right maxilla; on the right, the tritoral surface of the parasphenoid. Between them there is a toothed and pitted bone (*pal.*) which appears to have been folded longitudinally through pressure. This bone is taken to be the palatine. The parasphenoid, as seen, probably does not represent the whole width of this bone, but posteriorly it was at least 12 mm. wide. The bones, both upper and lower, of this triturating apparatus appear to be masses of dense osseous tissue penetrated by deep pits. On the outer border of the palatine are numerous sharp teeth. No teeth are observable on the border of the maxilla, but doubtless the shallow pits there seen lodged small teeth, as in the type specimen.

In both of the specimens described here there is present a broad thin bone which lies on the snout occupying the region between the anterior ends of the frontals and the premaxillæ. No median suture can be made out. Laterally the borders extend outward as far as the outer ends of the premaxillæ. This bone appears to be separated from the premaxillæ, but the evidence is not satisfactory. The bodies of the premaxillæ are perfectly distinct from each other, but the bone referred to may be their coössified ascending plates. In No. 2111 the bone extends backward about 15 mm. The large area occupied by this bone and its scale-like appearance indicate that it is not the ethmoid.

This species differs from *A. evolutus* in having a much narrower band of teeth on the dentary.

Anogmius aratus (*Cope*).

PLATE II.

Anogmius aratus COPE (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. III, 1877, p. 585.—STEWART (A.), Univ. Geol. Surv. Kan-

sas, VI, 1900, p. 340.—Woodward (A. S.), Cat. Foss. Fishes Brit. Mus. IV, 1901, p. 72.—Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 393.

The following description is based on the type of the species. The matrix containing this fish has apparently formed a large flattened concretion. Of this there are now in the possession of the American Museum four pieces. The largest block presents the head and the anterior half of the fin. Another has been split from the right side and presents the pectoral fin and some ribs and the imprint of some of the opercular bones. A third block shows the body in the region of the anal fin. This piece does not join accurately the largest block, but Cope did not believe that any considerable part was wanting. The fourth block contains the base of the caudal fin and about 10 vertebræ. Between this section and the third there is missing an unknown number of vertebræ, probably about 8. From a specimen of *A. polymicrodus*, studied at the University of Kansas, Dr. A. S. Woodward came to the conclusion that there were altogether about 80 vertebræ, of which nearly 40 were in front of the pelvic fins. This indicates that at least 10 vertebræ are missing in the abdominal region of our specimen and several others from the caudal region. The number of the type of *A. aratus* is 2403. With regard to the dorsal fin Professor Cope's statements are not as positive as the specimen seems to justify. The fin begins just above the hinder border of the operculum. Its first ray is supported by a strong interneural bone (Pl. II, *i. n.*). The succeeding interneurals diminish rapidly in size, so that after the sixth they are slender. Cope says that the fin is "continuous as far as the specimen is preserved in this region, viz., to the fifteenth vertebra behind the scapula." But there are 22 vertebræ preserved on the block and behind these are the imprints of 8 more; and there are impressions of interneurals as far as over the 28th vertebra. There is also the base of a dorsal ray over the 21st vertebra, so that the dorsal fin must have extended to this vertebra, at least. On the succeeding block there are interneurals and fin rays (*i. n.*, *d. r.*). Of the latter several must have had their origin

considerably farther forward, possibly on the anterior block. On the hindermost block again there are remains of 4 or 5 rays. If the latter represent a distinct fin the one in front must have ended very abruptly. To the writer it appears quite certain that there was a single dorsal fin and that this extended from near the head to near the root of the tail. This must have resembled considerably the fin of *Coryphæna hippuris* (Jordan and Evermann, Fishes of North and Middle Amer., pl. cxlix, fig. 402).

Unfortunately, throughout most of its length only the bases of the fin rays remain, so that we have little idea regarding the height of the fin. On the second block there are remains of about 9 rays and some of these were at least 75 mm. high.

As stated by Cope some portions of the anal fin are present (*a. r.*). It was certainly short, but its exact length cannot be ascertained. A part of the anterior ray is seen, and about 6 interhæmal supports (*i. h.*) may be counted; but weathering has removed most of the bones.

There are present the distal ends of about 5 rays of one ventral fin (*v. r.*). Their tips have reached the front of the anal. They are cross-segmented.

One pectoral fin (*pct.*) is well preserved. It has lain in the matrix with the distal end directed across the vertebral column and with the convex anterior border directed upward. It is represented, for the sake of convenience, in a different position in the figure, the figure of it being drawn from the block split from the one bearing the body of the fish. The fin is 220 mm. long and seems to have consisted of about 20 rays.

Only the base of the caudal fin is present. The rays are supported by a fan-shaped hypural bone. In front of this are seen the crowded terminal vertebræ. The fin rays appear to have been slenderer and more numerous than in *Pachyrhizodus*. No evidences of cross segmentation appear.

The ribs are long and slender, and they have apparently been connected with the vertebral centra by means of distinct pieces of bone, parapophyses, as in *Tarpon*, *Portheus*,

and some other fishes. Intermuscular bones are well developed, those arising just behind the head being especially long and slender.

Some scales are present. One is 18 mm. long and 5 mm. wide. The exposed portion is marked with lines radiating from the centre of growth.

Cope has described the form of the upper surface of the skull. It presents three planes, a median and two lateral. The median is narrow at the supraoccipital, but increases in width to the snout. The lateral planes are widest behind and narrow anteriorly. They slope off at an angle of about 30° with the median plane. The sides of the head are about vertical.

The bones of the upper surface of the skull in front of the orbits have been damaged. A portion of the frontals is gone, but the imprint of these and some splinters of the bones remain. Their anterior border cannot be determined exactly. The anterior extremity of the ethmoid is present and is thick and broad, as seen at the upper end of Fig. 23. Cope regarded this bone as the consolidated premaxillaries and thought that little if any of the ethmoid was exposed. The imprint of the premaxillæ and splinters of these bones still remain on the upper surface of the snout on a portion of the matrix which overlies the ethmoid. Again, a smooth articular surface is found at the proximal end of each of the maxillæ

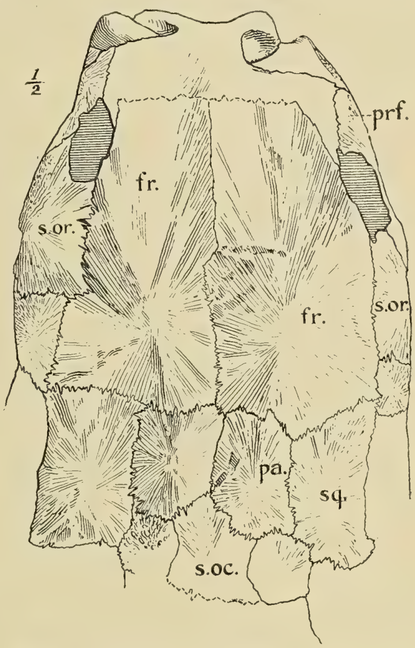


Fig. 23. *Anogmius aratus* Cope. No. 2403. × ½. Type. Head from above. *fr.*, frontal; *pa.*, parietal; *prf.*, prefrontal; *s. oc.*, supraoccipital; *s. or.*, supraorbital; *sq.*, squamosal.

(Pl. II, *mx.*), and these smooth surfaces must have been applied to the premaxillæ, unless the structure of this region was entirely different from that of *A. favirostris*. The premaxillæ have quite certainly been similar to those of Loomis's *Thryptodus zitteli*, and when present have nearly concealed the ethmoid. On the other hand, Loomis is probably mistaken in thinking that the premaxillæ of his species have coalesced with the ethmoid. His specimen and the type of *A. aratus* explain each other, and the explanation is confirmed by the types of *A. favirostris*. Whether or not the premaxillæ of *A. aratus* were coössified, we cannot be sure, No evidences of a median suture appear. Nor is it absolutely certain that the ascending processes of those bones were not united in *A. favirostris*.

The nasal cavities are situated above the level of the eyes and a little in front of them.

The bones of the upper surface of the head (Fig. 23) are in general like those figured by Loomis in his *Thryptodus zitteli*. The supraoccipital (*s. oc.*) does not separate the small and square parietals (*pa.*). Laterad of the last named bones are the large squamosals (*sq.*). The eye has been surrounded by a complete ring of bones. Over the eye are two sculptured supraorbitals (Fig. 23, *s. or.*). Behind the eye is the smooth postorbital (*pt. or.*); while in front is the prefrontal (*prf.*). This bone is sculptured above, but it sends downward in front of the orbit a long smooth process. Another elongated bone, apparently the preorbital, occupies the area between the prefrontal and the maxilla. The number of the bones covering the cheeks cannot be determined. They extend to the preopercular. The preoperculum (*p. op.*) and operculum (*op.*) are as represented in the plate. The other opercular bones were doubtless present, but are not preserved. The posttemporal (*pt.*) and the supracleithrum (*su. cl.*) are present. Of the cleithrum (*cl.*) only fragments remain on the block. An imprint of the coracoid is seen on the matrix below the throat. The articulation of the pectoral fin is high, being just below the vertebral column. If the precoracoid was present, it must have been short.

The articulation of the lower jaw is below the hinder half of the orbit. The articular sends up a strong hook-like process behind the quadrate. The maxilla is curved and does not extend back as far as to the quadrate. Neither the maxilla nor the mandible appears to have differed much from those of *Thryptodus zitteli*. The mouth has been relatively small and quite oblique.

The structure of the greater portion of the dental apparatus was unknown to Cope. He states that teeth are found on the ethmoid bone, his united premaxillæ; but the present writer has been able to find there only a slight roughness. When the fish died, the mouth was left in a gaping position. Recently the matrix has been removed from it to a depth of 98 mm. from the edge of the vomer. This reveals the fact that the mouth is armed with large bony plates which closely resemble those described by Loomis as belonging to *Thryptodus*. From a gelatine mold, plaster casts have been made of the upper surface of the mouth and of the floor. These have given much assistance to the artist in making drawings of the parts. The excavation of the cavity of the mouth did not extend quite to the hinder end of the plates, but must have approached them closely. In the front of the mouth we find a short, broad vomer (Fig. 24, *vom.*) which is covered with villiform teeth. Behind this is found a dental plate (*par.*) at least 82 mm. long and about 30 mm. wide. It has nearly parallel sides, and the lower surface is concave. The concavity is greatest just behind the middle. No doubt, this plate rests on the parasphenoidal bone, as in *A. favirostris*. On each side of this parasphenoidal plate and articulating closely with it is another plate (*pal.*), long, narrow in front, broadening behind, and convex in cross-section. These plates represent the palatine

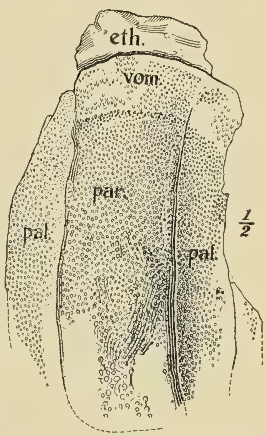


Fig. 24. *Anogmius aratus* Cope. Same specimen as Fig. 23. × ½. Roof of the mouth. *eth.*, ethmoid; *pal.*, palatine; *par.*, parasphenoid; *vom.*, vomer.

bones. The surfaces present the same structure as we have found in the case of the parasphenoid, being furnished with numerous pits. In places, all of these bones present evidences of attrition. Near the hinder end of the palatine is seen a portion of the ectopterygoid.

The floor of the mouth is occupied by two great convex plates which are joined by a transverse suture. The anterior (Fig. 25, *gl. h.*) has the form of the plate figured by Loomis (*op. cit.*, pl. xxi, fig. 4a) as the entoglossal, although it is smaller than the one figured by this writer. The length and breadth are each about 34 mm. It is strongly convex from side to side. The posterior plate (*b. br.*) is still more convex than the anterior, especially behind. The hinder border has not been exposed, so that we do not know its form and whether or not it was followed by a third plate. Both these plates are everywhere pitted, and the posterior one, which has fitted into the concavity of the parasphenoidal plate, is worn smooth over a considerable part of its surface. It is quite certain that these two plates have been developed on the glossohyal and the basi-branchials. Doubtless the structure of these plates is the same as that of the plates described under *A. altus*. Figure 26 illustrates a section across the mouth at about the middle of the basi-branchial plate (Fig. 25, *b. br.*) and some distance in front of the hinder end of the parasphenoidal plate (Fig. 24, *par.*). The line above *b. br.* represents the upper surface of the basi-branchial plate. The upper line shows the vaulted roof of the mouth as formed by the parasphenoidal plate (*par.*) and the right and left palatines (*pal.*).

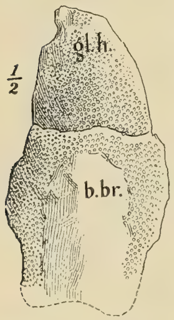


Fig. 25. *Anogmius aratus* Cope. Same specimen as Fig. 23. × ½. Floor of the mouth. *b. br.*, basi-branchial; *gl. h.*, glossohyal.

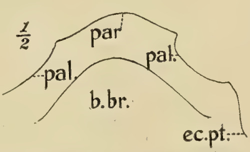


Fig. 26. *Anogmius aratus* Cope. From same specimen as Figs. 23–25. × ½. Diagrammatic section across the cavity of the mouth. *b. br.*, basi-branchial; *ec. pt.*, ectopterygoid; *pal.*, palatine; *par.*, parasphenoid.

It is quite certain that the specimen described by Dr.

Loomis as *Thryptodus zitteli* belongs to the same genus as the one here described, but it is also quite as certain that it represents a different species. It appears to have had a flatter skull and probably a blunter snout. Furthermore, the upper and the lower dental plates were all proportionally shorter and broader than in *A. aratus*.

Anogmius altus (*Loomis*).

Syntegmodus altus Loomis (F. B.), Palæontogr. XLVI, 1900, p. 253, pl. xxii, fig. 9.—Woodward (A. S.), Cat. Foss. Fishes Brit. Mus. IV, 1901, p. 84.—Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 390.

Dr. Loomis's type of this species included the hinder portion of the skull and the parasphenoid. The specimen is figured by him so as to present a lateral view.

No. 2112 of the American Museum of Natural History is a part of the Cope Collection, and was collected by C. H. Sternberg in 1877, probably in Gove County, Kansas. It furnishes about the same parts as does Loomis's specimen; but it is crushed obliquely downward. Figure 27 presents a

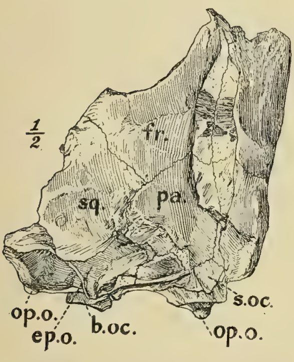


Fig. 27. *Anogmius altus ?* (Loomis). No. 2112. × ½. Upper hinder part of skull. *b. oc.*, basioccipital; *ep. o.*, epiotic; *fr.*, frontal; *op. o.*, opisthotic; *pa.*, parietal; *sq.*, squamosal.

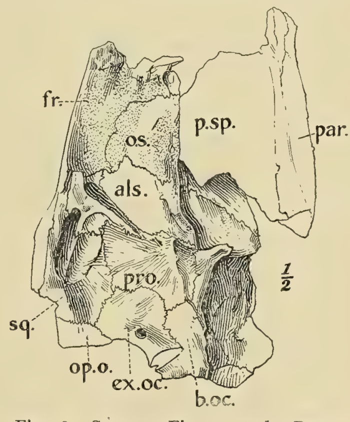


Fig. 28. Same as Fig. 27. × ½. Base of skull. *als.*, alisphenoid; *ex. oc.*, exoccipital; *op. o.*, opisthotic; *o. s.*, orbitosphenoid; *par.*, parasphenoid; *pro.*, proötic; *p. sp.*, presphenoid; *sq.*, squamosal.

view from above; Figure 28 from below. The specimen cannot be identified with certainty as *A. altus;* since, as will

be observed, in the type of the species the anterior edge of the presphenoid is but little in front of the middle of the parasphenoidal triturating surface; while in the specimen here described the presphenoid comes much farther forward. These differences may be individual, however.

As will be observed, the supraoccipital lies some 25 mm. to the right of the basioccipital, having been crushed to the right and downward. This shows that the skull must have been elevated at least that many millimeters above the foramen magnum, a conclusion which is confirmed by the skull described by Dr. Loomis. About 20 mm. in front of the hinder extremity of the supraoccipital begins an abrupt depression. It is about 10 mm. wide, and extends well forward on the frontals. From Fig. 28 the position and boundaries of the various bones may be seen. In general, these agree with those shown in the specimen described by Loomis as *Thryptodus zitteli* (*op. cit.*, pl. xxi, fig. 1). On the left the opisthotic, sphenotic, and hinder part of the frontal are in their natural positions and form the border of the skull. On the right the squamosal has been flexed downward at right angles with the surface of the skull. The border of the frontal on the left has probably been bent downward somewhat more than in life.

Figure 28 presents the skull as seen from below, only the outlines of the presphenoid (*p. sp.*) and parasphenoid (*par.*) being drawn. This bone will be described below. The observer must imagine himself as turning it to the left until it stands at right angles with the paper, and has the triturating surface (*par.*) facing him.

In this figure the proötics are drawn as meeting in the midline. This cannot be certainly affirmed; but the appearances are to that effect. There appears to have been a considerable excavation of some sort beneath the projecting edge of the squamosal and outside of the hyomandibular articulation. The alisphenoids are large, agreeing with those of Dr. Loomis's figure of *A. altus*. We come now to the bone called by Dr. Loomis the orbitosphenoid. It appears to agree with the bone so-called by Parker (Philos. Trans. Roy. Soc., CLXIII,

1874, pl. vii.). There is, however, satisfactory evidence of a pair of bones, or more probably of an unpaired bone with right and left wings, which is placed in front of the alisphenoids. This bone, marked *o. s.* in Figure 28, is certainly not the lower surface of the frontal, and there is a plain suture for union with the alisphenoid. The lateral edge of this bone is not so certainly determined, but seems to be where drawn in the figure. The surface for articulation with the large median bone (Figs. 28, 30, *p. sp.*), lies about 10 mm. to the left (right in the figure) of the midline between the frontals. This distortion could not occur if the bone (*p. sp.*) were articulated to the under surface of the frontals. Hence, I hold that the bones *o. s.* are the distinct, or more probably united, orbitosphenoids, while the bone (*p. sp.*) is the presphenoid. The latter would occupy the position of the presphenoidal cartilage shown in Fig. 10 of Pl. v and Fig. 10 of Pl. vii of Parker's paper just quoted. Dr. Loomis's figure of *A. altus* also shows an arch of bone running upward and outward from the upper edge of the bone called by him orbitosphenoid. It is above these bones that the anterior portion of the brain and the olfactory nerve must have lain.

The parasphenoid of this specimen must have had a median process behind, like that represented in Loomis's drawing (Fig. 10, Pl. xxii). At the anterior end of the lower surface of the supposed proötics, in the midline, there is an excavation in which this process must have been lodged. As already stated, the parasphenoidal grinding plate is deeply pitted (Fig. 29). Where a small fracture occurs it is seen that these pits pass down to the bone of the ordinary sort on which the denser mass reposes. Accompanying this plate is another bone which is represented by Fig. 31. This was broken, and the injured end has been ground down to show

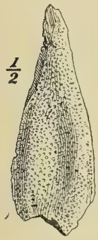


Fig. 29. *Anogmius altus?* (Loomis). Same individual as Figs. 27, 28. × ½. Parasphenoid, palatal surface.

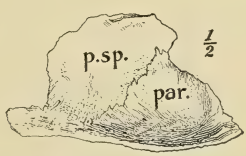


Fig. 30. *Anogmius altus?* (Loomis). Same individual as Figs. 27–29. × ½. Lateral view of parasphenoid and presphenoid.

the structure. Fig. 32 shows a small portion magnified two times. The pits and cavities in the bone are shown by the black. It will be observed that the pits penetrate nearly the whole thickness of the bony mass. Loomis has described the dense mass which forms the bulk of these triturating plates as "dentine" and "osteodentine." I do not discover the peculiar structure of dentine in any of them. The canals which Dr. Loomis calls "Haversian" appear to be the pits which open on the surface. To me the plates appear to be merely a kind of dense bone, similar to that found on the maxilla and premaxilla outside of the mouth cavity; and these bones display not very dissimilar pits. Dr. Woodward has mentioned the presence of dentinal tubules in *Plethodus* (Ann. and Mag. Nat. Hist., Ser. 7, Vol. III, p. 355). Unfortunately he has not furnished figures of these microscopical elements, or given us their dimensions. What is the function of these pits, and how they have been produced, the present writer does not attempt to explain. It would be interesting to know how these bony masses increased in thickness.

Fig. 31. *Anogmius altus?* (Loomis). Same individual as Figs. 27–30. × ½. Inferior grinding plate.

Fig. 32. *Anogmius altus?* (Loomis). Section through bone of Fig. 31. × 2.

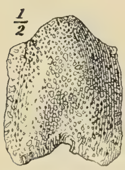


Fig. 33. *Anogmius* sp. No. 994. × ½. Inferior dental plate.

Seen from the lower side this bone is ornamented with fine ridges, which run, for the most part, longitudinally and anastomose, but which, in some parts, run in other and often irregular directions. In cross-section these ridges form narrow perpendicular plates, as appears at the bottom of Fig. 32. They appear to be similar to the fine ridges found by Dr. Woodward in similar situations in *Plethodus*.

The convex surface of this plate fits well the concave surface of the upper plate. Fig. 33 presents a view of the grinding surface of a lower dental plate collected for the author in the region of Butte Creek, Kansas, but which is now the property of the American Museum. It is strongly convex

above, concave below. The ends have evidently been suturally joined to other bones; so that it has apparently been the middle one of a series of at least three bones forming a triturating plate. In this bone, as in No. 2112, the pitted surface gives evidences of polishing through use. No evidences of teeth are to be found on the central portions of this plate, but around the borders, especially in front, many small, sand-like teeth are observed. These are clustered on the ridges of dense bone surrounding the pits, as seen in Fig. 34, which represents an enlarged view of the surface of Fig. 32 bounded by the two fractures on the upper left-hand border. The pits are shown in black; the teeth by the small circles. This bone closely resembles the one figured by Stewart (Univ. Geol. Surv. Kansas, VI, 1900, pl. lxvii) as a pharyngeal of *Anogmius polymicrodus*.

Fig. 34. *Anogmius* sp. Enlarged view of part of Fig. 33. × 2.

Fig. 35. *Anogmius* sp. No. 1116. × ½. Lower anterior dental plate.

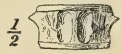


Fig. 36. *Anogmius* sp. No. 1116. × ½. Caudal vertebra.

Fig. 35 represents an upper view of another lower dental plate which evidently belongs to some species of *Anogmius*. The upper surface is in general convex, but the central and hinder part is somewhat concave. On each side of the concavity a ridge runs forward to about the middle of the length. Here it divides, one branch running outward to the border of its side. The other unites with the corresponding ridge of the other side, and the single ridge thus formed continues to the anterior end of the triturating surface. In front of the pitted mass of dense bone there is a thin expansion of ordinary bone. On the right-hand side of the figure this does not appear, but this is because it has been crushed downward and to the left beneath the part seen. It seems most probable that this bone is the glossohyal. It belongs to the same specimen as the piece of tail represented by Fig. 16. Fig. 36 gives a view from above of a caudal vertebra of the same specimen, No. 1116. There are seen the pits for the reception of the neural arches.

There is also presented on each side an outstanding process which is found on some of the vertebræ of some members of the genus. They occupy a position about the middle of the height of the vertebral centrum and near the hinder end.

Anogmius evolutus *Cope.*

Anogmius evolutus Cope (E. D.), Proc. Amer. Philos. Soc. XVII, 1877, p. 179. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 347, pl. lxv, fig. 7; pl. lxvii. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 72. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 393.

Osmeroides evolutus Loomis (F. B.), Palæontogr. XLVI, 1900, p. 257, pl. xxvi, figs. 5, 6.

Beryx multidentatus Stewart (A.), Kansas Univ. Quart. VII, 1898, p. 196.

The type of this species is here figured (Fig. 37). The original description given by Professor Cope seems to be sufficiently clear and accurate. Dr. Loomis has figured a mandible and premaxilla of what appears to be this species. His specimen is different from that described by Cope in having the band of teeth wholly on the inside of the dentary, instead of having it about equally distributed on the inside and the outside of the bone. Fig. 37 shows how much of the

Fig. 37. *Anogmius evolutus* Cope. No. 2101. × ⅓. Type. Lower jaw, view of inner surface; detached figure, a portion of outer surface. *art.*, articular; *den.*, dentary.

band of teeth was on the inside of the jaw in the type of the species; the detached part of the figure represents the teeth on the outer side of the jaw. It is possible that the difference in the two specimens is due to the crushing of one or the other; but of which, it is now impossible to say.

A comparison of the figure of the premaxilla given by Dr.

Loomis shows that this bone must have been quite like that of *A. favirostris*, in both form and sculpture.

Cope's type of *A. evolutus* was, according to Mr. C. H. Sternberg's diary of his expedition of 1877, found near the line between Lane and Gove counties, Kansas. It is now No. 2101 of the American Museum of Natural History.

ELOPIDÆ.

Spaniodon simus *Cope.*

PLATE IV, FIGS. 1 AND 2.

Spaniodon simus COPE (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV, 1878, p. 69. — WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 53. — HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 391.

Illustrations are herewith presented of the specimens from which Professor Cope drew his description of this species. He has mentioned the possession of three specimens, of which one, said to be nearly entire, served as his type. These specimens are now in this Museum. Fig. 1, Pl. IV, is taken from No. 2508; Fig. 2 of the same plate, from No. 2509. On the block containing the latter specimen are remains of one or more fishes lying behind and above the fish represented on the plate, but it is doubtful whether or not they belong to the latter. In any case the vertebræ are all wanting. Yet it is from this fish that most of the description of the head is derived. Both specimens are labelled by Cope as being his types.

Little criticism can be made on Cope's description. To the writer it appears evident that the lower portion of the body was scaled. The dorsal and anal seem to have had each about two rays fewer than the numbers given in the original description.

The number of vertebræ in this fish is less than in any of the other described species. *S. latus* (Agassiz) is stated by Dr. A. S. Woodward (Cat. Foss. Fishes, IV, p. 53) to have 50 vertebræ, whereas the present species has only 45.

The depth is contained in the length to the end of the vertebral column three and one-half times; the length of the head in the same distance about three and one-third

times. Three other species, *S. blondeli* Pictet, *S. elongatus* Pictet, and *S. latus* (Agassiz) are found in the upper Cretaceous of Sahel Alma, Mt. Lebanon.

On the block bearing No. 2509 are found written in pencil the words "Yankton, Neb." Professor Cope merely stated that the specimens came from Dakota. The formation and locality are therefore as follows: Niobrara Cretaceous, Yankton, South Dakota.

ICHTHYODECTIDÆ.

Saurocephalus *Harlan.*

So far as has yet been shown the only difference between *Saurocephalus* Harlan and *Saurodon* Hays is found in the presence in the former of a row of foramina, one foramen for each tooth, placed some distance from the dental border of the jaws, upper and lower, while in *Saurodon* there is at the base of each tooth a deep notch. In the latter genus the notches are often converted into foramina by the growth of bone across the notch. There can be little doubt that the foramina of *Saurocephalus lanciformis* originated from notches like those of *Saurodon leanus*. Whether or not this difference shall be regarded as sufficient to indicate distinct genera may be a matter of individual judgment. The writer has preferred to retain all the species under *Saurocephalus*.

These openings in the bones of the jaws have been called nutritive foramina, and as such Dr. Woodward speaks of them in the final volume of his work on fossil fishes. There can be little doubt that it is through these foramina that the young teeth enter the sockets. The writer has ground down a small piece of a jaw of this genus and found the very young tooth at the bottom of one of these foramina, lying against the functional tooth. As growth occurs, the root of the tooth pushes itself above the foramen, while the blade grows toward the dental border. It is very improbable that any nutrient vessels enter the sockets through these foramina. From Dr. Loomis's memoir I gather that the view here presented is also that of Dr. Röse.

Saurocephalus phlebotomus *Cope.*

Saurocephalus phlebotomus Cope (E. D.), Proc. Amer. Philos. Soc. XI, 1870, p. 530; U. S. Geol. Surv. Wyoming, etc. 1871, p. 416; Proc. Amer. Philos. Soc. XII, 1871, p. 343. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 386.

Daptinus phlebotomus Cope (E. D.), Proc. Acad. Nat. Sci. Phila. 1873, p. 339; Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 41; Vert. Cret. Form. West, 1875, pp. 213, 275, pl. xlvii, figs. 3, 4, 6; pl. xlix, figs. 1–4. — Newton (E. T.), Quart. Jour. Geol. Soc. XXIV, 1878, p. 440. — Zittel (K. A.), Handbuch Palæont. III, 1890, p. 264.

Saurodon phlebotomus Cope (E. D.), Bull. U. S. Geol. Surv. III, 1877, p. 588. — Stewart (A.), Kansas Univ. Quart. VII, A. 1898, p. 186; Univ. Geol. Surv. Kansas, VI, 1900, p. 312, pl. lvii, figs. 4, 5. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 248, pl. xxiv, figs. 1–5. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 112.

Daptinus phlebotonum Crook (A. J.), Palæontogr. XXXIX, 1892, p. 123.

The type of this species is in the American Museum and has the number 1906. There are present all of the left maxilla, except the distal end; the alveolar border of the right maxilla; both palatine malleoli; and considerable parts of both dentaries, including the symphysis and surface for articulation of the predentary. All the parts are more or less fragmentary; but it is believed that they furnish a correct idea of the tooth lines, both of the maxillæ and the dentaries. The conclusion is reached that there were not more than 40 teeth in each dentary and about 30 in each maxilla.

Fig. 38. *Saurocephalus phlebotomus* Cope. No. 1907. × ½. Premaxilla, inner view.

The specimen which Stewart has described and figured as *Saurodon phlebotomus* (Univ. Geol. Surv. of Kansas, VI, p. 312, pl. lvii, figs. 4, 5) is quite certainly such. On the other hand, the specimens described and figured by Loomis (Palæontogr., XLVI, p. 248, pl. xxiv, figs. 1–5) are probably not of this species. In these there are 47 teeth in the dentary. Likewise, the premaxilla does not resemble that of one of

the specimens which Cope has (and, so far as I can see, correctly) identified as *S. phlebotomus*. This specimen, No. 1907, is here figured (Fig. 38) and it will be seen that it is much more pointed than is the one figured by Dr. Loomis. The latter is probably *S. xiphirostris* Stew., the premaxilla of which is shown here by Fig. 39.

There seems to be only one objection to Stewart's identification of his specimen, and that is found in the relative lengths of the dentary and maxilla. Cope's specimens indicate that the dentary projected farther in front of the premaxillaries than Stewart's figures would suggest. The tooth line of the dentary of Cope's type must have had a length of 98 mm.; the maxillary tooth line a length of 60 mm. If now we add to the latter 20 mm. for the premaxilla, we have 18 mm. for the distance which the dentary projected beyond the premaxillary. How the discrepancy is to be explained is now uncertain.

Saurocephalus lanciformis *Harlan.*

Saurocephalus lanciformis Harlan (R.), Jour. Acad. Nat. Sci. Phila. (1), III, 1824, p. 337, pl. xii; Trans. Geol. Soc. Penn. I, 1834, pt. i, p. 83; Med. and Phys. Res. 1835, pp. 286, 289, 366. — ? Morton (S. G.), Amer. Jour. Sci. XXVIII, 1835, p. 277. — Owen (R.), Odontog. 1845, p. 130, pl. lv. — Giebel (C. G.), Fauna Vorwelt, I, pt. iii, 1848, p. 89. — Leidy (J.), Proc. Acad. Nat. Sci. Phila. 1856, p. 302; Trans. Amer. Philos. Soc. XI, 1857, p. 87, pl. vi, figs. 8–11. — Pictet (F. J.), Traité Paléont. 1854, ed. 2, p. 93. — ?? Spillman (W.), Hilgard's Rep't on Geol. Miss. 1860, pp. 142, 389. — Cope (E. D.), Proc. Amer. Philos. Soc. XI, 1870, p. 530; U. S. Geol. Surv. Wyom. 1871, p. 415; Vert. Cret. Form. West, 1875, pp. 216, 275. — Davies (W.), Geol. Mag. (2), V, 1878, p. 260. — Newton (E. T.), Quart. Jour. Geol. Soc. XXXIII, 1878, p. 786. — Stewart (A.), Kansas Univ. Quart. VII, 1898, p. 186. — Hay (O. P.), Amer. Jour. Sci. (4), VII, 1899, p. 299, figs. 1–4. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 251, pl. xxv, figs. 2–5. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 392. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 113. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 386.

Saurodon lanciformis Hays (I.), Trans. Amer. Philos. Soc. (2), III. 1830, p. 477, pl. xvi, fig. 11.

Saurocephalus arapahovius COPE (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 343; U. S. Geol. Surv. Mont. 1872, pp. 344, 348; Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 41; Vert. Cret. Form. West, 1875, pp. 216, 275, pl. xlix, fig. 5. — WOODWARD (A. S.), Cat. Foss. Fishes IV, 1901, p. 114. — HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 385.

Saurocephalus arapalovius LOOMIS (F. B.), Palæontogr. XLVI, 1900, p. 251 (syn. of *S. lanciformis*).

The type of Cope's *Saurocephalus arapahovius* is in the Cope Collection, now belonging to the American Museum of Natural History, and has the number 2073. It is a fragment of the maxilla. Cope distinguished his species from *S. lanciformis* on the ground that the facets shown by Leidy to exist on the roots of the teeth of the latter were absent in the former. Loomis unites the two species because he regarded the presence of facets to be variable. I have exposed the root of one of the teeth of the type of *S. arapahovius* and find that there are very distinct facets. There appears, therefore, to be no reason for retaining it as a distinct species.

Saurocephalus xiphirostris (*Stewart*).

Saurodon xiphirostris STEWART (A.), Kansas Univ. Quart. VII, 1898, p. 178, pl. xiv; Univ. Geol. Surv. Kansas, VI, 1900, p. 314, pl. lv. — LOOMIS (F. B.), Palæontogr. XLVI, 1900, p. 247. — WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 113.

Saurocephalus xiphirostris HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 386.

Saurodon phlebotomus LOOMIS (F. B.), Palæontogr. XLVI, 1900, p. 248, pl. xxiv, figs. 1–5.

I find difficulty in estimating the value of Stewart's species, *Saurodon broadheadi*, *S. ferox*, and *S. xiphirostris*. There is at least one good species among these; if only one, it must bear the earliest name, *broadheadi*. *S. ferox* appears to differ from *S. broadheadi* in having the maxilla proportionally a little higher. It has also an unusually large number of teeth in the maxilla, 40; an unusually small number, 46, in the dentary; and only 10 in the premaxilla. The number is variable, however; a specimen, No. 1614, referred to *S.*

xiphirostris, having 32 in one maxilla, 35 in the other; 50 teeth in the dentary; and 11 in the premaxilla. Another has 32 and 34 teeth in the maxillæ, 50 in the dentary, and 13 in the premaxilla. However, it is probably better for the present to regard the three species as distinct.

No. 1614 (Figs. 39, 40) was collected in 1877, in Gove County, Kansas, by Mr. R. Hill, for Professor Cope. It consists of both upper jaws complete; the left palatine complete, or nearly so; the greater part of both lower jaws; one quadrate; and the predentary. The number of the teeth has been stated. The predentary has a length of 55 mm., a vertical diameter of 27 mm. at the base, and a transverse diameter of 16 mm. It does not appear to have suffered any crushing. The premaxilla is represented by Figure 39 for comparison with that of *S. phlebotomus*.

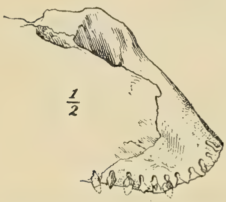


Fig. 39. *Saurocephalus xiphirostris* (Stewart). No. 1614. × ½. Premaxilla, inner view.

The palatine has the form represented in Fig. 40, seen from the outside. The mesial surface is concave in cross-section. On this surface are seen two considerable patches of small teeth, and probably the whole surface was originally furnished with teeth. Attached to the hinder end of the upper border of the maxilla is a supramaxilla.

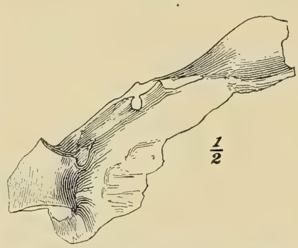


Fig. 40. *Saurocephalus xiphirostris* (Stewart). No. 1614. × ½. Palatine, outer view.

No. 2012 has 35 teeth in the maxilla. The predentary is 66 mm. long and 28 mm. high.

Saurocephalus goodeanus (*Cope*).

Ichthyodectes goodeanus Cope (E. D.), Proc. Amer. Philos. Soc. XVII, 1877, p. 176. — Hay (O. P.), Amer. Jour. Sci. (4), VI, 1898, p. 227; Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 385. — Woodward, (A. S.), Cat. Foss. Fishes, IV. 1901, p. 107.

In the Cope Collection of fossil fishes has been found Cope's type of his *Ichthyodectes goodeanus*. It proves to be a species

of *Saurocephalus*, belonging to the section or subgenus *Saurodon*. Its number is 2110. It is difficult to understand how Professor Cope came to refer the species to *Ichthyodectes*, since the forms of the maxillary, premaxillary, and palatine,

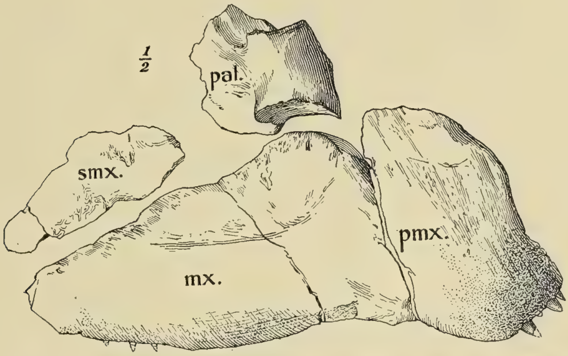


Fig. 41. *Saurocephalus goodeanus* (Cope). No. 2110. × ½. Type. Upper jaw, outer view. *mx.*, maxilla; *pal.*, palatine; *pmx.*, premaxilla; *smx.*, supramaxilla.

and the presence of notches at the bases of the teeth plainly indicate its relationship with *Saurocephalus phlebotomus* (Fig. 41).

Cope's description agrees in almost every respect with the specimen, but in one or two cases there is some apparent lack of agreement, due evidently to a misuse of terms. He states that "the maxillary border is incurved at its anterior extremity," etc. This is exact, if instead of maxillary we read premaxillary. That the latter is meant is indicated by the statements "the middle part of the border being most prominent," and "the anterior border is sigmoidally curved," statements true of the premaxilla, but having little or no significance when applied to the maxilla. The statements as to the number and character of the premaxillary teeth are correct. As Cope says, the maxillary teeth are round in section; but there can be little doubt that if we had the crowns of these teeth they would be found to be two-edged, as are those of the premaxilla. Cope's measurements are correct.

This species differs from all other described species of

Saurocephalus in its heavy structure. The bones are much thicker than those of specimens which I refer to *S. xiphirostris*, as the following measurements indicate.

	S. xiph.	*S. good.*
Thickness of premaxilla 20 mm. above alveolar border	8 mm.	12 mm.
" " maxilla 10 mm. below condyle	8 mm.	12 mm.
" " " 10 mm. above alveolar border at middle of length	5.5 mm.	7.5 mm.

The exact length of the maxilla cannot be determined, but it is quite evident from the way in which the alveolar border is curved upward posteriorly and the small size of the teeth that the bone did not extend much farther backward. Alveoli for 31 teeth are counted; and there are six alveoli in 20 mm. The palatine malleolus, measuring from the articular surface for the maxilla to that for the prefrontal, is high; not low, as we find it in *Ichthyodectes*.

The supramaxilla (Fig. 41, *smx.*) is present. In the drawing this bone is lifted somewhat above its natural position. It is flat on the outside. On the mesial side it is traversed longitudinally by a sharp ridge.

This species was collected by C. H. Sternberg's party during the year 1877, probably in Gove County, Kansas.

The maxilla figured by Stewart as the type of *Saurodon broadheadi* resembles in outline and proportions that of *Saurocephalus goodeanus*, but Dr. S. W. Williston has kindly given me measurements which show that Stewart's species is everywhere much thinner. At 10 mm. below the condyle the thickness is only 7 mm.; at middle of length, 10 mm.; above the lower border, only 4.5 mm.

Ichthyodectes anaides *Cope.*

Ichthyodectes anaides Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 339; 5th Ann. Rep. U. S. Geol. Surv. Mont. etc. 1872, p. 343; Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1874, p. 40; Vert. Cret. Form. West, 1875, pp. 206, 274, pl. xliv, figs. 14, 15; pl. xlv, figs. 1–8. — Crook (A. R.), Palæontogr. XXXIX, 1892, pp. 111, 123, pl. xv. — Hay (O. P.), Amer. Jour. Sci. (4),

VI, 1898, p. 226, fig. 2; Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 384. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 244. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 296, pl. xlix, figs. 1–3. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 100.

Portheus arcuatus Cope (E. D.), Vert. Cret. Form. West, 1875, p. 274, pl. xlvii, figs. 7–9.

This is one of the commoner species found in the Niobrara beds of Kansas, and it has been figured by Cope, Crook, Hay, and Stewart. As shown by some of the published figures and by specimens in the American Museum, the mouth has been very oblique. The eyeball is large, as shown by the preserved sclerotic bone.

Crook has figured portions of the shoulder girdle and the first pectoral ray. As in the case of *Portheus*, he has mistaken the upper end of the clavicle for the lower, and consequently the right for the left fin. The first pectoral ray has the same structure as that of *Portheus*, but has evidently been proportionately shorter and more curved distally.

An examination of the original of Cope's figures 7–9, pl. xlvii, 'Vertebrata of the Cretaceous Formations of the West,' has convinced me that they belong to this species and not to *Gillicus arcuatus*. Crook has already surmised this to be true (Palæontogr., XXXIX, p. 112). The skull is shorter and broader and of heavier construction.

After examining skulls of *Portheus*, *Saurocephalus*, and *Gillicus* I am confirmed in my opinion that the parietals are united in the mid-line and lie in front of the supraoccipital. They form the base of the great crest at the back of the head, and extend slightly backward on each side like the horns of a crescent. Posteriorly these horns join the anterior prolongations of the epiotics. I have not been able in any case to discover sutures between the parietals and the epiotics, but doubtless these exist.

No. 2005 of the American Museum was collected in 1877, in Gove County, Kansas, by Russell Hill. It furnishes a complete head, 19 anterior vertebræ, the shoulder girdle, and the first rays of both pectoral fins. Unfortunately, the head

is somewhat distorted and crushed, and the greater part of the shoulder girdle hidden. Above each orbit are two supraorbitals, one behind the other and each about 25 mm. wide. There are remains of a supramaxilla, but its limits are not definable. A portion of the palatine behind the malleolus has been exposed in life. Below and behind the eye the bones of the palatopterygoid arch have been wholly hidden by the suborbitals. The boundaries between these latter bones cannot be made out, the bones themselves having probably been very thin. If correctly identified, the supracleithrum is large, about 160 mm. long and 50 mm. or more wide. The preopercular resembles that of *Portheus*. The opercle is large. All the opercular bones are roughened, as if there had been here and there bony nodules. The cleithrum appears to have a backwardly extending flap behind the articulation of the jaw.

The head of this specimen has been shortened by distortion, but must have been, from snout to gill clefts, about 300 mm. long. The length of the whole fish must have been about 5 feet (1.64 m.).

The vertebræ of this species resemble those of *Portheus*. In his description of these (Vert. Cret. Form. West, p. 207) Cope states that the ribs are not articulated directly to the centra, but by means of free elements which were inserted into the lateral grooves. Had I been aware of this fact when writing my observations on the vertebral column of *Portheus* (Zoöl. Bull., II, 1898, pp. 25–54) I might have been saved from the blunder which I there made, that of calling the upper side of the vertebral column the lower. The sections of the column there studied had been crushed so that the ribs of opposite sides had been brought into close contact and so as to resemble neural arches. In *Tarpon*, with which they were being compared, there are also free parapophyses, but posteriorly these diminish and disappear. In *Portheus*, on the contrary, as is now realized, these parapophyses increase in size toward the tail region, and the same is probably true in the cases of other members of the family.

Ichthyodectes multidentatus *Cope.*

Ichthyodectes multidentatus Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, pp. 339, 342; 5th Ann. Rep. U. S. Geol. Surv. Montana, etc. 1872, p. 343; Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1874, p. 41; Vert. Cret. Form. West, 1875, pp. 212, 275, pl. l, figs. 6, 7. — Crook (A. R.), Palæontogr. XXXIX, 1892, p. 123. — Hay (O. P.), Amer. Jour. Sci. (4), VI, 1898, p. 227; Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 385. — Loomis (F. B.), Palæontogr. XLVI, 1900, pp. 243, 245, text figs. 8, 9; pl. xxiii, fig. 9. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 107.

This species was based on a premaxilla and a fragment of the maxilla, and these parts were figured as cited above. The type now bears No. 2186 of the American Museum of Natural History. Afterward a more complete specimen was secured and described. This is now No. 1743 of this Museum and is represented in Figure 42. The identification of this with the type is doubtless correct. Only a part of a single tooth of the type remains, but this shows the presence of the ridges and furrows which are so distinctly seen in Cope's second specimen (Fig. 42, *t.*).

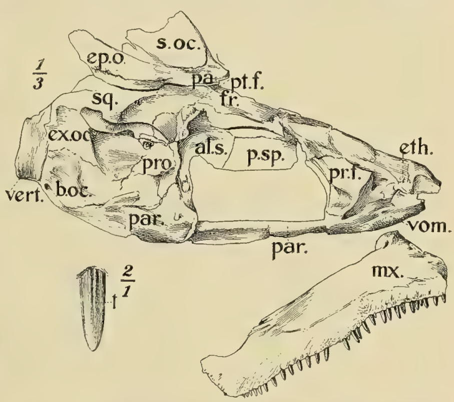


Fig. 42. *Ichthyodectes multidentatus* Cope. No. 1743. Skull × 1/3; tooth × 2. *als.*, alisphenoid; *b. oc.*, basioccipital; *ep. o.*, epiotic; *eth.*, ethmoid; *ex. oc.*, exoccipital; *fr.*, frontal; *mx.*, maxilla; *pa.*, parietal; *par.*, parasphenoid; *prf.*, prefrontal; *pro.*, proötic; *p. sp.*, presphenoid; *ptf.*, postfrontal; *s. oc.*, supraoccipital; *sq.*, squamosal; *vert.*, vertebra; *vom.*, vomer.

The skull of this specimen is much crushed and broken, but nevertheless much may be learned from it. In general form it resembles that of *Gillicus arcuatus* (Cope), although the bones are not so thin. As in that species, there is a strong upward flexure of the axis in the basisphenoidal region. The snout is pointed, and there is a high supraoccipital crest. The maxilla has been described by Cope. It bears teeth, or spaces for them, to the

number of about 50. Loomis states that there are about 44 teeth. The maxilla which he figures in outline (*op. cit.*, p. 45) is slenderer than the one here figured and of a somewhat different form. Loomis also figures what he regards as the mandible of this species.

In No. 1743 there is a deep excavation in the sides of the skull just below the articulation of the hyomandibular. This is seen also in the skull of *Portheus*, and is probably found in the skulls of all members of the family. The supraoccipital and the epiotic have been broken from the skull and replaced, as shown. Just above the line of fracture is the very distinct suture which passes between this bone and the squamosal. Another suture starts well up on the front of the supraoccipital crest, descends for a short distance, then turns backward. The bone in front of and below it is undoubtedly the unpaired parietal. Cope mistook the epiotic for the parietal. The suture in front of and below the parietal is effaced by the fracture. I have not been able to find a suture separating the parietal from the epiotic, but such no doubt exists. In a former paper (Zoöl. Bull., II, 1898, pp. 25–54) I have announced such to be the position of the single parietal; but its bounding sutures are not often easily seen. One specimen will reveal one suture, another specimen another suture. In a specimen of *Portheus*, No. 2373 of this Museum, both the upper and the lower sutures are distinct. Such a disposition of the parietals doubtless characterizes all members of the family.

The palatine has been provided with a patch of small teeth. The malleolus for union with the maxilla is low, broad, and flat.

The interorbital septum of the species under consideration appears to be occupied by a presphenoid; and above this there were probably orbitosphenoids. The vomer is beset by a patch of teeth.

As has been stated by Cope, the scapula and part of the cleithrum are present. This author states that the width of the cleithrum ("clavicle") below the scapula is 40 mm. This shows that he mistook the upper for the lower end of the

cleithrum; for the lower end is missing (Fig. 43). On the inside of the cleithrum there is a precoracoid which ascends from the coracoid three-fifths the distance to the upper end of the cleithrum. This precoracoid, which is like that of *Portheus*, was doubtless regarded by Cope as the coracoid. There are two large convex surfaces for articulation with the fin, the uppermost with the large first ray, the lowermost with the first baseost. On a level with the latter, but more mesiad, are two pits, undoubtedly for the reception of the next two baseosts. The proper interpretation of these parts is made easy by comparison with the shoulder girdle of a tarpon or salmon.

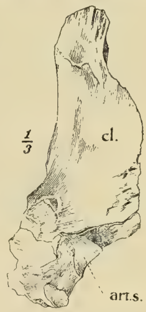


Fig. 43. *Ichthyodectes multidentatus* Cope. No. 1743. × 1/3. *cl.*, cleithrum; *art. s.*, articular surface for fin ray.

Gillicus *Hay.*

The type of this genus is Cope's *Portheus arcuatus*, later called by him *Ichthyodectes arcuatus*. Dr. A. S. Woodward (Cat. Foss. Fishes, IV, 1901, p. 101, pl. viii) has recently described a second species, *Gillicus serridens*, from the Albian epoch, Kent, England, under the name *Ichthyodectes serridens*. It differs in having the anterior mandibular teeth relatively larger. The members of this genus are well characterized by the falcate maxillæ, the reduced dentition, and the thin skull bones.

PACHYRHIZODONTIDÆ.

Pachyrhizodus *Agassiz.*

Cope originally made this genus the type of the family Pachyrhizodontidæ (Proc. Amer. Philos. Soc., XII, 1872, p. 343). Later he placed it in the family Stratodontidæ (Vert. Cret. Form. West, 1875, p. 219). Loomis and Stewart regard the relationships of the genus to be with the Salmonidæ. Dr. A. S. Woodward in his latest volume places the genus in the Elopidæ. To the present writer it seems best to retain it and its related genera in a special family as Cope originally did, until more is known regarding the anatomy.

Pachyrhizodus caninus *Cope.*

Plate III, Figs. 1 and 2.

Pachyrhizodus caninus Cope (E. D.), Proc. Amer. Philos. Soc., XII, 1872, p. 344; Rept. U. S. Geol. Surv. Mont. etc. 1872, p. 348; Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 42; Vert. Cret. Form. West, 1875, pp. 221, 276, pl. l, figs. 1–4. — Crook (A. J.), Palæontogr. XXXIX, 1892, p. 109. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 262, pl. xxvii, figs. 10–12. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 355, pl. lxx, figs. 2–6.— Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 44. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 387.

Pachyrhizodus latimentum Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 346; Rept. U. S. Geol. Surv. Mont. etc. 1872, p. 348; Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 42; Vert. Cret. Form. West, 1875, pp. 223, 276, pl. l, fig. 5; pl. li, figs. 1–7. — Loomis (F. B.), Palæontogr., XLVI, 1900, p. 263, pl. xxvi, figs. 7, 8. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 357, pl. lxviii; pl. lxx, figs. 9, 10. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 42. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 388.

Pachyrhizodus curvatus Loomis (F. B.), Palæontogr. XLVI, 1900, p. 265, pl. xxv, figs. 6–8. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 44. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 388.

The writer has ventured to unite the two species which Prof. Cope has described under the names *Pachyrhizodus caninus* and *P. latimentum*. The types of these are in this Museum, that of *P. caninus* having the number 1881; that of *P. latimentum* the number 1758. Besides these, there are various jaws and other parts which were collected for Prof. Cope by Messrs. Sternberg and Hill during the year 1877. In attempting to apply to this material the characters assigned by Cope to his two species the writer has become convinced that the differences are due partly to individual variations and partly to distortions during fossilization. The various collections indicate that the bones of this species were soft and spongy, so that they easily suffered compression and distortion. Jaw bones of the opposite sides of the same individual are sometimes so different that one is convinced with difficulty of their identity. The groove which divides

the symphyseal surface of the dentary of *P. latimentum* is very distinct in specimens which on account of the small height of the coronoid process would have to be assigned to *P. caninus*. The height of the coronoid process will, with little doubt, be found to vary in all degrees between the measurements given by Cope for his two species.

The mandible of the species (Fig. 44) appears to have had an external vertical surface and an inferior nearly horizontal surface. In some specimens these are separated by a sharp ridge; in others they are with difficulty distinguishable, a condition probably due to distortion during fossilization. Similarly, the maxilla has presented an external nearly flat surface separated by a sharp border from a flat superior surface. This surface, again, meets a flat palatal surface at a sharp internal, or mesial, border. The section of the maxilla

Fig. 44. *Pachyrhizodus caninus* Cope. No. 1662. × ⅓. Mandible. *ang.*, angular; *art.*, articular; *den.*, dentary.

is, therefore, nearly triangular. In one specimen, however, the maxilla of one side has the form described, while the other is so distorted that its section is nearly parallelogrammic. These modifications are mentioned in order to show the necessity of guarding against giving too much value to variations in the forms of the bones of this genus.

Of the palatines and the pterygoids of this species the writer has been able to learn little. Loomis (*op. cit.*, pl. xxvii, fig. 12) has figured what he regards as a palatine, but it seems to be identical with a left maxilla in this Museum's collection. Besides, one would hardly expect to find a palatine of a length so great that it would reach nearly to the quadrate.

In the National Museum at Washington there is a specimen of this species which I have been permitted to study.

It appears to have been about six feet (1.83 m.) in length. The skull measured about 275 mm. Unfortunately, the right preopercular and some other bones are lying on the top of the skull, so that the relations of the elements were not determined. The preopercle had a length of at least 225 mm.; and at the lower end, a part of which is missing, a width of about 112 mm. A quadrate has a height of 85 mm. There are 53 vertebræ present, but they are considerably disturbed. Of these apparently 27 belong to the caudal region. The neural arches appear to have been slender and not high. The tail is deeply forked. The lower lobe only is present. Its length is about 375 mm., but a ray near the bottom of the fork is only about 90 mm. long. There are about 10 rays in the lobe, not including 5 rudimentary rays on the front edge. The first of the latter is a lunate bone, the others are slenderer and straight or irregularly bent. The terminal vertebræ are not shorter than those farther forward in the caudal peduncle and hence do not display the crowded condition seen in *Anogmius*. There is a fan-shaped hypural. The pectoral fin is long and falcate. The anterior ray measures close to 595 mm. It has a width of 27 mm. at the base and tapers gradually to the tip. It is not divided or segmented. Eleven rays may be counted in this fin, but probably a few are missing. The shortest one observed measures 135 mm. All except the most anterior divide distally into slender filaments. At the base of the fin are seen two or three baseosts. There appear to be no remains of dorsal, ventral, and anal fins. The shoulder girdle of the left side is displayed from the inner surface (Fig. 45). It is

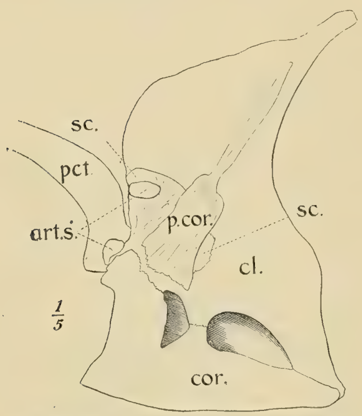


Fig. 45. *Pachyrhizodus caninus* Cope. U. S. Nat. Mus. × 1/5. Shoulder girdle. *art. s.*, articular surfaces for fin; *cl.*, cleithrum; *cor.*, coracoid; *p. cor.*, precoracoid; *pct.*, pectoral fin ray; *sc.*, scapula.

much like that of *Tarpon*, but the precoracoid is larger than in the latter genus. On the other hand, it is smaller than in *Portheus*. In the specimen under consideration it is about 125 mm. long. The shoulder girdle is here illustrated from a rough sketch.

On Plate III, Fig. 1 is shown a view of the tail of this species taken from No. 1900 of the American Museum. The tips of the lobes are broken away so that the original dimensions cannot be known, but the lobes are now respectively about 265 mm. and 335 mm. in length. There is a large terminal fan-shaped bone, which supported the principal rays. On each side there is a triradiate bone, apparently a modified ray, lying on the terminal vertebral bodies. Ryder (Report U. S. Fish. Com. for 1884, pl. vi, fig. 2) has figured a similarly placed bone which he regards as growing out from a displaced epural. In front of the lower lobe of the fin of *Pachyrhizodus* here described is an excavation which probably has been occupied by a lunate bone such as that referred to above as being found in the specimen at Washington. Fig. 2 of Plate III shows a nearly complete lobe. Its length is 435 mm. In these fins the rays are few in number, large, and cross-segmented. The fin resembles considerably that of *Tarpon*. Its number is 1658.

Dr. Loomis has described a species which he calls *P. curvatus*. It is small, the tooth line of the dentary measuring only 50 mm. In this space are alveoli for 38 teeth. The maxilla possessed alveoli for 41 teeth. The species appears to the present writer to be a young individual of *P. caninus*. In the type jaw of *P. caninus* are spaces for 38 or 40 teeth, and in a maxilla I count at least 40 teeth. Professor Cope regarded this fish as probably a ground feeder, but the form of the tail seems to indicate a swift, free-swimming, predaceous animal.

No. 2041 of this Museum consists of 9 caudal vertebræ and apparently 15 rays of an unpaired fin. There can be little, if any, doubt that the fin belongs with the section of the vertebral column, but whether it is the anal or the dorsal cannot be ascertained. The longest rays measure 147 mm.

in length, but the tips are broken off. From the anterior they grow shorter and slenderer to the last. Probably nearly the whole, if not the whole, of the fin is present. The rays divide longitudinally into slender portions but show no signs of segmentation. The nine vertebræ have a length of 185 mm., and the fin has about the same length along its base.

Pachyrhizodus leptopsis *Cope.*

Pachyrhizodus leptopsis Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 42; Vert. Cret. Form. West, 1875, pp. 225, 276, pl. li, figs. 8–8c. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 354, pl. lxx, fig. 1. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 45. — Hay (O. P.), Bibliog. and Cat. Foss Vert. N. A. 1902, p. 388.

Pachyrhizodus lepitopsis Loomis (F. B.), Palæontogr. XLVI, 1900, p. 264.

This species was based on a fragment of a right dentary which presents the symphyseal surface. The specimen bears the Museum's number 1756. The species is characterized by the large size of the bases of the teeth and the narrow symphyseal articulation. The bases on which the teeth rest are large, fully as wide as long, and the empty spaces from which the teeth have fallen are about circular. In *P. caninus* the teeth are crowded, so that the tooth bases, measured across the jaw, are wider than long, and the empty spaces are of greater extent across the jaw than parallel with it.

Oricardinus sheareri *Cope.*

Pachyrhizodus sheareri Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 347; U. S. Geol. Surv. Wyoming, etc. 1872, p. 348; Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 43; Vert. Cret. Form. West, 1875, pp. 225, 276. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 45.

Oricardinus sheareri Cope (E. D.), Proc. Amer. Philos. Soc. XVII, 1877, pp. 177, 178. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 388.

Pachyrhizodus sheari Loomis (F. B.), Palæontogr. XLVI, 1900, p. 264.

The type of this species is supposed to be a portion of the left maxilla. A figure and section of the specimen is here-

with presented (Fig. 46). The anterior end of the fragment is directed toward the right. The teeth are pleurodont, as they are in *Pachyrhizodus*. They have been crowded, as in *Pachyrhizodus caninus*, but none of the crowns has been preserved. The roots present at least one difference from the species of *Pachyrhizodus*, so far as I have been able to observe. In the latter, when the tooth separates from the root, which is buried in the bone of the jaw and becomes anchylosed with it, the ring-like edge of the root is very sharp. In *O. sheareri* the remains of the root form a nearly flat ring around the pulp cavity. This, looked at with a lens of high power, shows radiating and concentric lines of dense bone. Nearly all the teeth of the specimen appear to have been shed at the time of its death; very few seem to have been broken off afterward. The Museum number of the type is 1998.

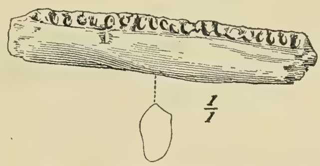


Fig. 46. *Oricardinus sheareri* Cope. No. 1998. × 1. Type. Maxilla and section.

Oricardinus tortus *Cope.*

Oricardinus tortus Cope (E. D.), Proc. Amer. Philos. Soc. XVII, 1877, p. 177. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 46. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 388.

The type of this species is in the American Museum of Natural History and has the catalogue number 2114. The material consists of a part of the left mandible, including the symphysis, and possibly about twenty vertebræ. Figures of the mandible are here presented showing it from the lingual side (Fig. 47) and from the dental border (Fig. 48). In his description, Cope deals much with the internal and external ribs of this mandible, but it is difficult even with the specimen in hand to understand his meaning. The jaw has evidently suffered some distortion and this has resulted in making some of the anterior teeth appear to lie on the outer side of the jaw. The teeth are much like those of *Pachyrhizodus*, but the symphysis is different and the jaw is narrower in

front, like that of *Empo*. Nevertheless, the narrowness may be due to crushing, and cannot be relied on. The vertebræ accompanying the jaw may be said to be identical with those

Fig. 47. *Oricardinus tortus* Cope. No. 2114. × 1. Type. Dentary. *sym.*, symphysis.

Fig. 48. Same as Fig. 47. Shows tooth line.

Fig 49. ? *Oricardinus tortus* Cope. No. 2114. × 1. Two caudal vertebræ, lateral view.

of *Empo* in structure, and it is not improbable that they did not belong to the individual that possessed the jaw. Two caudal vertebræ are figured here of natural size (Fig. 49). Until more is known about the species it seems best to retain it in the genus *Oricardinus*, of which it is the type.

ENCHODONTIDÆ.

Enchodus *Agassiz.*

Remains of fishes of this genus are very common in collections made in the Cretaceous of Kansas, and they likewise occur in collections made in New Jersey. Fourteen species have been described from these two States and another, *E. shumardii*, from South Dakota. The greater part of the species have been based on detached teeth. The most conspicuous bone of the skull and the one most likely to be preserved is the greatly swollen palatine, bearing a long fang. This bone was regarded by Cope as the premaxilla, and the pterygoid, which articulates with it behind, was supposed to be the maxilla. The correct interpretation was afforded by Dr. A. S. Woodward (Proc. Geologists' Assoc., X, 1888, p. 315). Dr. Loomis has more recently discussed the anatomy of the genus, but in his restoration of the skull he has not represented the palatine as swollen nor drawn the boundary between it and the ectopterygoid. He also describes the

palatine as a mass of osteodentine; but to the present writer this mass, as also that composing the tritoral plates of *Anogmius*, appears to be merely very compact bone.

Dr. Loomis has probably given us the correct explanation of the replacement of the palatine fangs. The new fang is produced in front of the senescent one. Originally the latter had stood on the very anterior extremity of the palatine bone, but after the tooth had become affixed, the bone prolonged itself in front of the base of the tooth and thus provided a surface for the attachment of the next fang in succession. When the new tooth has taken its position, its predecessor, through absorption of its base, is loosened and drops away, leaving a crescentic scar. Sometimes several of these scars may be observed on the palatine. The new tooth probably became firmly fixed before its predecessors fell away; otherwise it would have been easily wrenched from its moorings. It will probably also be found that there is an alternation in the replacement of the fangs. Evidence of this is found in the palatines of No. 2098. The right palatine has a conspicuous process of bone extending forward over the base of the fang. The left palatine has only the slightest trace of such a process.

The large teeth on the anterior end of the pterygoid are replaced also by the development of others in front of them; and the scars resulting from the falling away of the old teeth may be seen. On the other hand, the great fang on the anterior end of the dentary is replaced by the growth of another behind it, and the scars of former teeth lie in front of the functional fang. Prof. Cope's figure (Vert. Cret. Form. West, pl. liv, fig. 3) shows the end of the right dentary from without. The functional fang is broken off some distance above its base. In front of it is an elevation of bone on which stood the replaced fang. In the specimen, the surface of the scar looks as if the old fang had only recently been broken off. Cope's figure 3*a* is unsatisfactory. Other specimens of *Enchodus* confirm the conclusion that the new fang of the dentary is produced behind the old one. Thus, while the fang of the palatine is moving forward, that of the dentary is

moving backward; but it is probable that growth of other parts makes compensations, so that the two fangs are always closely opposed to each other. Cope (*op. cit.*, p. 301) has described the mode of succession of the teeth of the dentary.

Enchodus ferox *Leidy.*

Enchodus ferox Leidy (J.), Proc. Acad. Nat. Sci. Phila. 1855, p. 397. — Emmons (E.), Man. Geol. 2nd ed. 1860, p. 214, fig. 1824. — Cope (E. D.), Vert. Cret. Form. West, 1875, p. 277. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 277. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 204. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.

Enchodus pressidens Cope (E. D.), Proc. Amer. Philos. Soc. XI, 1869, p. 241; Vert. Cret. Form. West, 1875, p. 277. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 277. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 205. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.

"*Sphyræna*" Morton (S. G.), Synop. Org. Rem. Cret. U. S. 1834, p. 32, pl. xii, fig. 1.

In the Cope Collection are two palatines belonging to the genus *Enchodus*, both of which are labelled in Cope's handwriting. One of these, No. 2251, is labelled "*Enchodus ferox*"; the other, No. 2250, "*Enchodus pressidens*, not typical." Fig. 50 represents the specimen of *E. ferox*. A study of these has led to the conclusion that the two species, *E. ferox* and *E. pressidens*, are identical. The characters which are relied on to distinguish *E. pressidens* are the crescentic section of the base of the palatine fang, the triangular section of the middle of the tooth, the grooves bounding the cutting edges, and the projection of the base of the tooth beyond the anterior margin of the palatine.

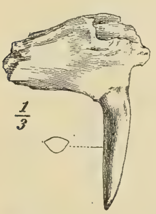


Fig. 50. *Enchodus ferox* Leidy. No. 2250. × 1/3. Palatine and fang, with section.

As to the crescentic base, this results from the pressure of the hinder side of the new tooth against the base of the old tooth, and there is some reason for believing that the concavity of the posterior side of the new tooth diminishes somewhat after the old tooth has fallen out. At any rate, such an explanation is suggested by a

difference found in the form of the bases of the two fangs of a specimen of *E. petrosus.* As regards the cross-section at the middle of the tooth, I find no considerable difference. The specimen labelled "*E. pressidens*" agrees with the description of that species, but the "*E. ferox*" also has the inner face considerably more convex than the outer, and the sections of these faces may be regarded as forming two sides of a triangle, with the separating angle rounded off. The grooves bounding the cutting edges of "*E. pressidens*" are hardly apparent, while there are indications of them in the specimen called *E. ferox.* Doubtless there were individual variations in this character.

If Loomis's explanation of the manner of replacement of the palatine fangs is correct, as it quite certainly is, we can see why in some cases the palatine bone projects beyond the base of the fang, while in other cases the fang projects beyond the bone. After the new tooth has taken its position in front of the old tooth and at the very extremity of the palatine bone, the latter proceeds to extend itself forward in order to provide a seat for the base of the next tooth in succession. Thus we sometimes get a palatine bone in one stage, sometimes in another. In the "*ferox*" specimen the palatine had extended considerably in front of the fang; in the "*pressidens*" specimen the fang had only recently taken its place.

The specimen called *E. pressidens* is a little more than one-half the size of that called *E. ferox*, the tooth being 32 mm. long, that of *E. ferox* 51 mm. The palatine bone of the "*pressidens*" is also relatively slenderer than the other; but all these differences are probably due to difference in age of the animals.

E. ferox appears to differ from *E. petrosus* in three respects. The inner face of the palatine fang is smooth, while in *E. petrosus* it is coarsely striated. In *E. ferox* the cutting edges of the palatine fang are minutely serrated; in *E. petrosus* they are smooth. In both species there is, on the outside of the palatine, a broad shallow groove which runs from the lower hinder portion of the bone upward and forward. In *E. ferox* this groove meets the upper edge of the bone over

the base of the fang; in *E. petrosus*, well behind its base. The drawings of *E. ferox* furnished by both Morton and Emmons of this species represent the teeth only and are very unsatisfactory. I find no reason for questioning the correctness of Cope's identification of the tooth here figured as *E. ferox*. *E. ferox* and *E. pressidens* Cope were both described from the Cretaceous of New Jersey.

Enchodus petrosus *Cope*.

Enchodus petrosus Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1874, p. 44; Vert. Cret. Form. West, 1875, pp. 239, 278, pl. liv, figs. 4–7. — ? Loomis (F. B.), Palæontogr. XLVI, 1900, p. 278, pl. xxvii, figs. 13–15. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, pl. lxx, fig. 11. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 205. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.

Tetheodus pephredo Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 43; Vert. Cret. Form. West, 1875, pp. 237, 277, pl. liv, figs. 1–3. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 205. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.

Tetheodus pephero Loomis (F. B.), Palæontogr. XLVI, 1900, p. 278 (syn. of *Enchodus petrosus*).

The present writer agrees with Dr. Loomis in referring Cope's *Tetheodus pephredo* to *Enchodus petrosus*. The type of this supposed species is in this Museum and has the number 1605. Cope's description and figures are for the most part correct.

Prof. Cope states that in *Tetheodus pephredo* there is no surface for the attachment of a tooth and no scar or other trace of the former existence of one. However, a close examination of one of the palatine masses shows that there are traces, faint but undeniable, of at least four fangs which at different times have occupied the lower border of the bone. Moreover, where we would expect to find a functional fang, the surface is somewhat rough; while on the oral border of the bone there is a ragged area which looks as if some of the bone had been broken away. All this makes it appear probable that in some conflict both fangs had been torn away at their

bases, and that sufficient time had not elapsed for the scars to be wholly healed. In front of and above the base of the supposed former fang, on the anterior extremity of the palatine, there is a process of bone which may be regarded as an outgrowth preparatory to the attachment of a new fang. It is rather thin from side to side, only about one half as thick as would be required for the fang, but it is possible that its thickness might become greater in due time. Whether or not a new fang could be produced and effect an attachment without the support and protection of a fang already in place seems to be doubtful. It seems likely that every victim by its strugglings would destroy any incipient connections that had been formed.

Fig. 51 represents a damaged dentary bone of this species, with two teeth nearly complete. The most anterior of these is shown two-thirds of the natural size, in order to display the rather strongly developed ridges on the posterior half of the tooth. On the lingual face of the tooth these ridges are found well forward, but here they are rather short. Toward the hinder border of this face they rise well toward the tip of the tooth. About three millimeters above the base of the tooth the ridges cease suddenly, and the portion of the surface below them is provided with very fine striations. The anterior fang is broken away, but its outlines are restored from another specimen. The number is 2062.

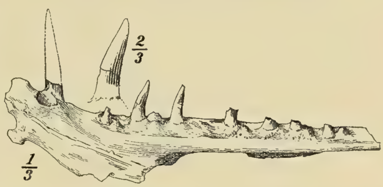


Fig. 51. *Enchodus petrosus* Cope. No. 2062. Dentary, × ⅓; one tooth, × ⅔.

The surfaces by means of which the palatine bone comes into contact with the bone which acted as its suspensory, doubtless the prefrontal, deserve description. These articulatory surfaces are found at the hinder end of the palatine, and those of Cope's type are shown in Fig. 62; those of *E. sævus* in Fig. 61. In the former we have two processes, one below and directed upward and outward. The posterior face of this is smooth and forms one of the articulatory surfaces.

Another process is considerably in front of the one just described, and is directed upward. Its posterior face is flat and smooth. The inner face of the lower and hindermost process looks upward and inward, and is slightly convex and smooth. It connects the two articulatory surfaces which are directed backward and form a third surface. A thin perpendicular plate of bone has extended backward from the inner border of the anterior articular surface near the base of the posterior process, but it is now broken away. It is seen in the figure of the corresponding parts of *E. sævus*. It appears evident that the posterior process in *E. petrosus* has been distorted, so that its upper surface is directed more outwards than in life. For the same reason, it is now lower than originally. This is indicated by another specimen. Through these smooth articulatory surfaces the palatine must have had a very free movement on the prefrontal.

Portions of the palatine fangs of an *Enchodus* from the Fox Hills Group of New Mexico are not distinguishable from those of *E. petrosus*. (Cope, Amer. Naturalist, XXI, 1887, p. 566.)

Enchodus dolichus *Cope.*

Enchodus dolichus Cope (E. D.), Vert. Cret. Form. West, 1875, pp. 239, 278, 300, pl. liv, figs. 8, 8a; Proc. Amer. Philos. Soc. XXIII, 1885, p. 3. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 279, pl. xxvii, figs. 16, 17. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 377, pl. lxx, fig. 12. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 204. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.

Of this species the type, a fragment of the palatopterygoid, is in the Museum and bears the number 1820. There are likewise considerable portions of three skulls, including those described by Cope on page 300 of his 'Vertebrata of the Cretaceous Formations of the West.' One of these skulls, Cope's "No. 1," No. 1837 of this Museum, is represented by Fig. 52. It displays both palatines, the right much out of its natural position, the left pushed backward about 25 mm. Its great fang is crossed by the anterior end of the ectopterygoid. The long teeth of the latter bone are well shown.

The anterior end of the mandible is broken away. Above the palatine is the right premaxilla with about 23 teeth and spaces for others. Between the upper and the lower thirds of the figure lie the occipital bones and the frontals. The left articular runs forward beneath the left palatine. The

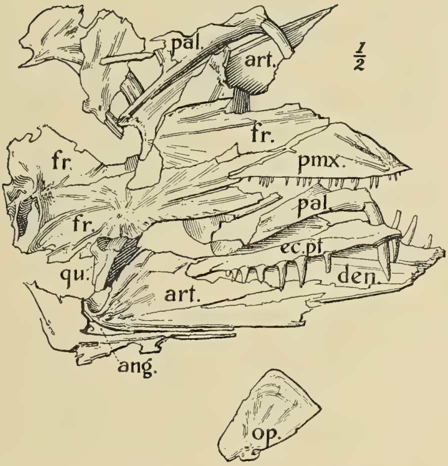


Fig. 52. *Enchodus dolichus* Cope. No. 1837. × ½. Disturbed skull. *ang.*, angular; *art.*, articular; *den.*, dentary; *ec.pt.* ectopterygoid; *fr.*, frontal; *op.*, opercular; *pal.*, palatine; *pmx.*, premaxilla; *qu.*, quadrate.

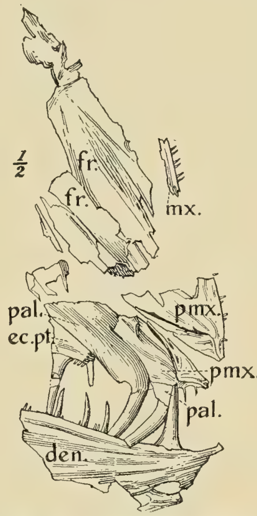


Fig. 53. *Enchodus dolichus* Cope. No. 1685. × ½. *den.*, dentary; *ec.pt.*, ectopterygoid; *fr.*, frontal; *mx.*, maxilla; *pal.*, palatine; *pmx.*, premaxilla.

right quadrate is displaced so that its articular surface (above *qu.*) looks upward.

Figure 53 represents No. 1865 of this Museum. This displays both palatines and their fangs; the anterior end of the ectopterygoid and two teeth; the lower jaw, with its fang and teeth of two sizes; both premaxillæ, with their small teeth; and the anterior end of the frontal. Alongside of the frontal is a fragment of a toothed bone which lies on a line with the dental border of the premaxilla. It is probably a portion of the maxilla.

The palatine fang was missing in the type. No. 1837 shows, as Cope has already stated, that the palatine fangs are finely striated on the outer surface. On the hinder por-

tion of the inner face of the left palatine and of two mandibular teeth we find a moderately coarse striation. Cope's specimen "No. 2," which is No. 1890 of this Museum, presents both palatines, one with the fang complete. The ornamentation is as in No. 1837. The same is true of the fang of No. 1865, except that the striation, both on the inner and the outer face, is somewhat coarser. The striation of the hinder part of the inner face of No. 2385 is decidedly coarser than that of any of the other specimens. All these teeth show that *E. dolichus* differs from *E. petrosus* in having the outer face with practically the same convexity as the inner. The latter seems also to have attained a considerably larger size. We must, however, keep in mind that there are likely to be small specimens of *E. petrosus*.

Enchodus tetræcus *Cope.*

Enchodus tetræcus Cope (E. D.), Vert. Cret. Form. West, 1875, p. 278. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 205. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.
Enchodus tetracus Loomis (F. B.), Palæontogr. XLVI, 1900, p. 277. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 375.

This species is said to have been based on various teeth from the Greensand of Delaware and New Jersey. One whole tooth, which is labelled as the type, is in the Museum and has been given the number 2248. There is another with the distal end missing. Cope's description is sufficient, but it is thought to be proper to present here a drawing of the type (Fig. 54). Figure 55 represents the paratype, an imperfect tooth designated as No. 2249. The sharply defined striations of the very convex inner face distinguish this species from *E. ferox*. The teeth are apparently slenderer than those of *E. petrosus*, and the shallow

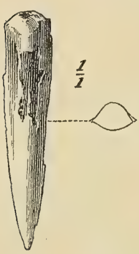


Fig. 54. *Enchodus tetræcus* Cope. No. 2248. × 1. Type. Palatine fang and cross-section.

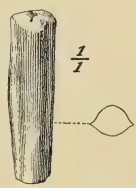


Fig. 55. *Enchodus tetræcus* Cope. No. 2249. × 1. Paratype. Palatine fang and cross-section.

grooves running along the inner face, one close to and parallel with each cutting edge, are somewhat more distinct; but these characters are hardly satisfactory. On account of the little that is known about *E. tetrœcus* and on account of the different geographical distribution, the two species may best be regarded for the present as distinct.

Enchodus gladiolus *Cope.*

Cimolichthys gladiolus Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 353.

Phasganodus ? gladiolus Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1872, p. 43; Vert. Cret. Form. West, 1875, pp. 235, 277.

Enchodus gladiolus Cope (E. D.), Vert. Cret. Form. West, 1875, p. 301, pl. xlii, fig. 7. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 204. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 389.

The type of this species was a single detached tooth, and this has not yet come to light in the examination of the Cope collection. Cope states (Vert. Cret. Form. West, p. 301) that he had a better specimen; but while he figured the type tooth, he did not figure or describe the better example. In the collection there is found a specimen which bears the label in Cope's handwriting "*Enchodus ?gladiolus*," the interrogation doubtless belonging, according to Cope's usage, with the specific name. To these remains have been given the number 1818. The specimen presents the left palatine, with its great tooth complete; the left ectopterygoid, with several teeth; and the tip of the left dentary with its fang. As shown in Fig 56, the ectopterygoid has been turned so that the teeth point in a direction opposite to that of the palatine teeth. On another block and apparently belonging to the same individual is shown the upper surface of the hinder half of the skull. The palatine fangs differ from those of *E. dolichus* in

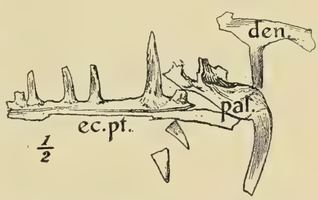


Fig. 56. *Enchodus gladiolus* Cope. No. 1818. × ½. Jaws. *den.*, dentary; *ec.pt.*, ectopterygoid; *pal.*, palatine.

having nearly the whole of both the inner and the outer face coarsely striated. The ridges and intervening furrows are easily seen with the unaided eye, while in the case of *E. dolichus* this requires a close observation. The striation subsides close to the anterior very thin edge. As in *E. dolichus*, the two faces are equally convex. The pterygoid and the mandibular teeth are similarly marked by coarse ridges and grooves.

It is possible that this specimen is only an example of *E. dolichus* with unusually coarse grooving of the teeth; but I think that it is distinct.

Fig. 57 represents the upper surface of the skull. The more anterior portions of the frontals have left their impression on the matrix but are not represented in the drawing. From each epiotic region a grooved ridge runs forward to the prefrontal region. From this ridge, at the centre of growth of the frontal bone, a less prominent ridge runs outward and backward to the middle of the squamosal. The epiotics are prominent and are connected by a sharp ridge, behind which the occiput drops off steeply. The parietals are apparently separated by the small supraoccipital. The parietals seem to form a narrow band along the ridge connecting the epiotics. The sutures are very indistinct.

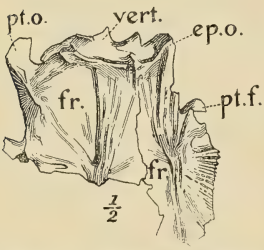


Fig. 57. *Enchodus gladiolus* Cope. No. 1818. × ½. Hinder part of skull. *ep.o.*, epiotic; *fr.*, frontal; *pt.f.*, postfrontal; *pt.o.*, pterotic.

Enchodus sævus, sp. nov.

This species, which appears to be distinctly different from any hitherto described, was collected near Elkader, Logan County, Kansas, by Dr. W. D. Matthew, in 1897. The collector regarded the beds as belonging to the Pierre formation; but Dr. Williston, who is familiar with the locality, informs me that the deposits belong to the Niobrara. The species has been a large one, as is indicated by the following measurements:

Length of the lower jaw from the chin to the articular condyle	223 mm.
Height of the jaw at the coronoid process	67 mm.
Breadth of the skull at the postorbitals	111 mm.
Length of the palatine and prefrontal to the front of the fang	72 mm.

Unfortunately the whole surface of the specimen has been covered and in some places injured by a deposit of crystals of gypsum, so that it is difficult to determine some structures. Other structures and the general forms of the bones are distinct enough. The number of the specimen is 198.

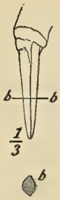
The distinguishing character of this species is found in the great palatine fang. In other American species of the genus where the palatine fang is known the latter is compressed laterally. In the present species the compression is nearly antero-posterior. The species is nearest to *E. petrosus*, with which it was at first identified.

The right palatine bone (Fig. 58) is in excellent condition, barring the deposit of gypsum on its surface. It has suffered little or no distortion or compression. No part of the ectopterygoid adheres to it. The figure represents the inner side of the tooth and shows the position of the inner, or posterior, cutting edge. The greater part of the fang is preserved. The left palatine is distorted and has lost all but the base of the fang.

Fig. 58. *Enchodus sævus* Hay. No. 198. × ⅓. Type. Right palatine bone and fang.

In *E. petrosus* a sharp cutting edge begins at the base of the fang in front and runs downward to the tip (Fig. 59). This is very distinct from the first, and it pursues its course near the anterior midline of the tooth, separating an outer from an inner face. The section shown in Fig. 59, *b*, ought to have been taken somewhat higher up on the tooth, in which case the inner face (on the left) would have been somewhat more convex, but it would still have differed much from Fig. 60, *a*. In *E. sævus* (Fig. 60) there is a faint trace of a corresponding edge and it may once have been stronger, but it lies much nearer the inner side of the tooth. Another cutting edge starts at the outer side of the base of the tooth; but, instead

of soon getting near the middle of the hinder surface of the tooth, as it does in *E. petrosus*, it forms the outer border of the tooth when this is looked at directly from behind or front. These two edges divide the surface of the distal end of the tooth into two nearly equal faces, of which one, somewhat smaller, is nearly anterior, but is directed somewhat outward, while the larger and somewhat more convex one is directed backward and inward. About the middle of the length of the tooth, where the section (Fig. 60, *a*) is taken, the inner face is far larger and more convex. The palatine bone, from which Fig. 60 is taken, was only slightly larger than that from which Fig. 59 was obtained.



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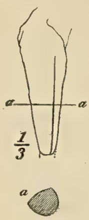

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Fig. 59. *Enchodus petrosus* Cope. No. 2062. × ⅓. Left palatine fang from in front. The line, *bb*, marks position of section *b*.

Fig. 60. *Enchodus sævus* Hay. No. 198. × ⅓. Type. Right palatine fang from in front. The line *aa* marks position of the cross-section *a*.

The palatine bone has about the size of that of *E. ferox*, figured in this paper, and the fang has probably had about the same length. If we measure the greatest diameter of this fang of *E. ferox* at a point 10 mm. below its base we find it to be 10 mm., and this diameter is the antero-posterior, while the transverse diameter is not quite 8 *mm.* At the same height the diameter of *E. sævus* is 10 mm. in the transverse axis of the cross-section, and 9 mm. in the antero-posterior. The same proportions and directions of the axes are found in *E. petrosus* as in *E. ferox*.

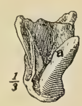

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Fig. 61. *Enchodus sævus* Hay. No. 198. × ⅓. Type. Posterior end of right palatine bone. *a*, articular process.

Fig. 62. *Enchodus petrosus* Cope. No. 1608. ×⅓. Type. Posterior end of left palatine bone.

The posterior end of the palatine (Fig. 61) appears to differ somewhat from that of *E. petrosus* (Fig. 62). It presents the same smooth articular surfaces as are observed in the latter species, but, as will be observed in the figures, the lower process, *a*, of the bone in *E. sævus*, is much thinner and higher than in *E. petrosus*. This difference may not be specific but due in some part to accidents of fossilization. Fig. 61 represents the bone of the right side; Fig. 62, that of the left side.

Fig. 63 represents the lower jaw seen from the outside. It is everywhere ornamented with radiating ridges and grooves. In front are three deep notches, as in many species of the

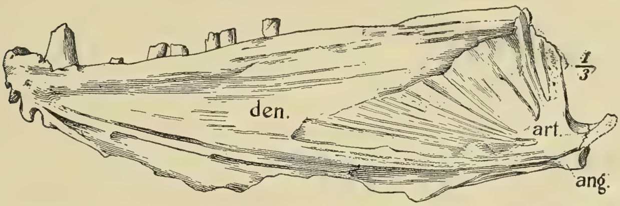

Fig. 63. *Enchodus sævus* Hay. No. 198. × 1/3. Type. Lower jaw, outer view. *ang.*, angular; *art.*, articular; *den.*, dentary.

genus. Fig. 64 shows the lower jaw from the lingual side, together with the ectopterygoid and quadrate. The two last-mentioned bones are somewhat displaced. Attention is called to the great raptorial tooth on the anterior end of the

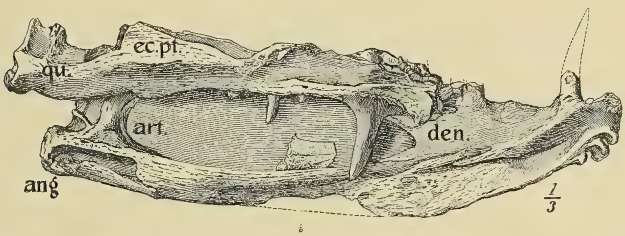

Fig. 64. *Enchodus sævus* Hay. No. 198. × 1/3. Type. Lower jaw, quadrate, and ectopterygoid; inner view. *ang.*, angular; *art.*, articular; *den.*, dentary; *ec. pt.*, ectopterygoid; *qu.*, quadrate.

ectopterygoid. It is about 30 mm. long. The upper border of the ectopterygoid is excavated in front and received the lower border of the palatine.

One preoperculum is present (Fig. 65). It appears to me to belong to the left side. It is very narrow above, but broadens somewhat below. The exterior surface is convex transversely and has ridges and grooves running lengthwise. A conical process from its front border fits into a groove in the hinder border of the quadrate. On the inner face of the preoperculum there is a deep channel running nearly the full length and opening forward. What I regard as the left interoperculum is shown in Fig. 65, *i. op.* A portion of its

hinder border has been broken away. It is a rather heavy bone and is ornamented with radiating ridges and grooves. The anterior border has been furnished with a row of about eight sharp processes. It seems to have been overlapped by the hinder border of the lower end of the preoperculum.

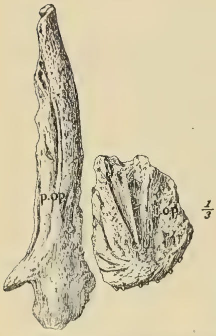

Fig. 65. *Enchodus sævus* Hay. No. 198. × ⅓. Type. *i. op.*, interoperculum; *p. op.*, preoperculum.

The upper surface of the head is present, except the snout; but it is too much overlain with gypsum to permit accurate description. It resembles the skull of *E. faujasi* Agassiz, which is figured by Dr. A. S. Woodward (Cat. Foss. Fishes, IV, pl. xi, fig. 6). A deep and broad excavation runs along the middle of the head from the supraoccipital.

Stratodus oxypogon *Cope.*

Stratodus oxypogon Cope (E. D.), Proc. Amer. Philos. Soc. XVII, 1877, p. 180. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p, 189. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 387.

The type of this species bears the number 2113. It consists of the distal portion of the right dentary (Fig. 66, *den.*), a portion of what Prof. Cope regarded as a maxilla (Fig. 66, *mx.*) a piece of a palatine (Fig. 67), and eight vertebræ. Cope

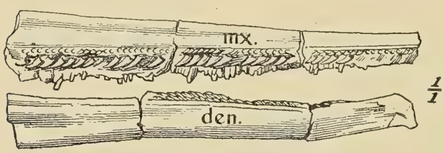

Fig. 66. *Stratodus oxypogon* Cope. No. 2113. × 1. Type. Jaws, outer view. *den.*, dentary; *mx.*, maxilla.

Fig. 67. *Stratodus oxypogon* Cope. No. 2113. × 1. Type. Fragment of palatine, showing teeth.

has given sufficient description; but no figures have hitherto been furnished of the specimens. The dentary and maxilla are here shown as seen from the outer side, and the fragment of palatine is represented from the toothed surface. Most of the teeth are pressed against the surface in such a way as to

suggest that they were hinged; as Cope also inferred from the form of the alveolar fossæ. This author has described the tips of the teeth as being simple; but in the case of some of them I find the peculiar spade-shaped apices which Cope has described in the case of *S. apicalis*. Fig. 68 shows two of the caudal vertebræ. They are much like those of *Empo*, but lack the longitudinal ribs of that genus. Under the lens, however, a fine longitudinal striation is seen on the sides of the centra. Dr. Woodward has placed this genus in the Dercetidæ, but notwithstanding the union of the parietals in the midline, it appears to the writer to belong to the Enchodontidæ.

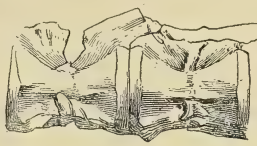

Fig. 68. *Stratodus oxypogon* Cope. No. 2113. × 1. Type. Two caudal vertebræ, side view.

Empo *Cope*

This genus was erected by Cope in 1872 (Proc. Amer. Philos. Soc., XII, p. 347). The type species is *E. nepaholica*, later emended by Cope to *nepæolica*. The species belonging to this genus have been referred by Loomis (Palæontogr., XLVI, 1900, p. 267) to *Cimolichthys;* and Dr. A. S. Woodward has more recently (Cat. Foss. Fishes, IV, p. 221) adopted the same course. That the two genera are not identical the present writer will not affirm; but the type species of *Cimolichthys*, *C. levesiensis*, is, as Dr. Woodward has said, not satisfactorily definable, many parts of the skull not being known. Likewise, we are in ignorance regarding various structures of *Empo*. It is therefore not at all improbable that differences of generic importance may yet be discovered in these types. It is as well to be conservative in suppressing genera as in establishing them. For these reasons the writer prefers to retain *Empo*.

Empo nepaholica *Cope.*

Pl. I. Fig. 4.

Empo nepaholica Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 347; Rep't U. S. Geol. Surv. Mont. etc. 5th Ann. Rep't, 1872, p. 345. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 387.

Empo nepæolica Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 46; Vert. Cret. Form. West, 1875, pp. 230, 279, pl. xlix, fig. 9; pl. l, fig. 8; pl. lii, fig. 1; pl. liii, figs. 3–5. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 332, pl. lix, figs. 1–9; pl. lxi, figs. 2–5.

Cimolichthys nepæolica Loomis (F. B.), Palæontogr. XLVI, 1900, p. 271, pl. xxvii, figs. 1–3. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 225, text figs. 8, 9.

Cimolichthys semianceps Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 351; Rep't U. S. Geol. Surv. Mont. etc. 1872, p. 326. — Loomis (F. B.), Palæontogr. XLVI, 1900, p. 273, pl. xxvii. figs. 4–6. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 228.

Empo semianceps Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 46; Vert. Cret. Form. West, 1875, pp. 233, 279, pl. liii, figs. 1, 2, 6–9. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 338, pl. lxi, figs. 6–9. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 387.

Cimolichthys sulcatus Cope (E. D.), Proc. Amer. Philos. Soc. XII, 1872, p. 351.

Empo sulcata Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. I, No. 2, 1874, p. 46.

Empo contracta Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 46; Vert. Cret. Form. West, 1875, pp. 232, 279, pl. liii, figs. 14–17. — Stewart (A.), Univ. Geol. Surv. Kansas, VI, 1900, p. 339. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 387.

Cimolichthys contracta Loomis (F. B.), Palæontogr. XLVI, 1900, p. 273, pl. xxvii, figs. 8, 9. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 228.

Empo merrillii Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. I, No. 2, 1874, p. 46; Vert. Cret. Form. West, 1875, pp. 232, 279, pl. liii, figs. 10–13. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 387.

Cimolichthys merrillii Loomis (F. B.), Palæontogr. XLVI, 1900, p. 272, pl. xxvii, fig. 7. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 228.

The type specimen of *Empo nepaholica* is a fragment of the hinder end of the palatine, which bears the bases of two large teeth and parts of smaller teeth, or bases thereof. It is figured by Cope as cited in the synonymy. The specimen is in the American Museum, and has the number 1904. After-

wards Cope identified as belonging to the same species much more satisfactory materials. One lot of these, No. 1736 of this Museum, was figured on plate lii, fig. 1, of his large work of 1875. Another, No. 1735, furnished figures 3–5 of plate liii of the same work. From these more complete materials many additional characters of the species were determined. In the paper in which *E. nepaholica* was described, Cope proposed also the new species *Cimolichthys sulcatus*, which he afterwards made a synonym of *E. nepaholica*. The type of this, No. 1882, is the left dentary, showing thirteen large teeth. The distal end of this dentary afterwards furnished figure 8 of plate l of the monograph of 1875.

The type of *Cimolichthys semianceps* consists of vertebræ, a palatine, portions of the dentaries with teeth, and some other parts. The vomer mentioned by Cope has not been recognized. The number of this type is 1989. In the monograph just mentioned Cope figured other specimens which he had identified as belonging to this species. One of these, now No. 1740, furnished figures 1 and 1*a* of plate liii; another, No. 1741, furnished figure 2 of the same plate; while No. 1742 was represented by figures 6–9.

Empo merrillii was based on fragments now included under the number 1737. There are present nearly the whole left palatine, of which figure 11 of plate liii of Cope's monograph represents the anterior end; a considerable part of the right palatine, one fragment of which is shown by figure 12; a flat bone, represented by figure 10, and which is probably the entopterygoid; and the vomer, represented by figure 13.

Empo contracta is likewise founded on fragments of jaws. There are present the right palatine, except its anterior extremity; the anterior extremity of the left palatine; the vomer; and the anterior portion of the left dentary. Most of these parts are represented on plate liii of Cope's work. The Museum number of this lot is 1738.

It may be said that the figures which Cope has published represent the originals adequately, and that nothing would be gained by refiguring them. If the figures are in some cases unsatisfactory the fault lies in the materials.

What is the value of these species? *E. contracta* is said to be characterized by the flatness of the "maxillary bone," by which is meant the palatine; but in the types the palatine of *E. merrillii* is still flatter, especially at the anterior end. To what extent the flatness of this bone in both species is due to its original form and to what extent to distortion during fossilization is hard to determine. There was probably considerable individual variation among these fishes. As regards the sizes of the teeth in different parts of the palatine, the writer has found, in looking through the collection of this Museum, so much variation that he regards the distinctions specified by Cope as of little or no value. Considerable differences are often to be observed on the opposite sides of the head. Cope also found characters in the "tongue-shaped pharyngeal bone," which is really the vomer; but after diligent comparison on the part of the present writer the attempt to find specific characters in this part was abandoned.

Prof. Cope has given extended and accurate descriptions of *E. nepaholica* and *E. semianceps;* but when we seek for the characters by which they may be distinguished from each other, they are found to be rare and elusive. The character which is most definitely stated is found in the structure of the mandibular teeth. In *E. nepaholica* these are said to possess no cutting edge on the posterior face. Unfortunately the crowns of the teeth are nearly always broken off, so that it is impossible to apply this test. The types themselves cannot, at least now, be distinguished in this respect. In another specimen I find a mandibular tooth with a posterior edge, but there is no other indication that it is not *E. nepaholica.* Both species possess such two-edged teeth on the palatines. On the lower jaw of a very large specimen in the Museum I find that the teeth are two-edged; and observation makes it certain that if such teeth belong only to *E. semianceps* this was not a smaller species than *E. nepaholica.* Stewart says that the mandibular teeth of specimens which he identified as *E. nepaholica* seemed to have both anterior and posterior cutting edges.

Having made an earnest effort to apply to the specimens in this Museum the characters presented by Cope as belonging to his species and such other characters as could be found, the writer has been compelled to abandon the attempt to retain the species founded by Cope and has found it necessary to reduce them all to the one having priority of description, *E. nepaholica.*

Dr. Loomis has furnished an excellent figure of the skull of this species, seen from the side, and other figures of the rear of the skull. A view of a well preserved skull is presented here (Fig. 69). The number of the specimen is 2522. The squamosal region of the left side has been damaged somewhat, and the drawing of this part is completed from another skull, No. 1888. On the right side a vertebra and some other elements are lodged against the skull behind the postorbital region. As both Loomis and Woodward have indicated, the very large frontals (Fig. 69, *fr.*) extend close to the hinder end of the skull. However, there is a narrow band of bone showing behind each frontal on the upper surface and extending from the supraoccipital outward to the epiotic process. These bands are doubtless the parietals. No suture is to be observed between the parietal and the epiotic, but it may have been present. The supraoccipital meets the frontals, thus separating the parietals. It sends on each side outward and backward a process which passes behind the inner end of the parietal. There is a deep fossa

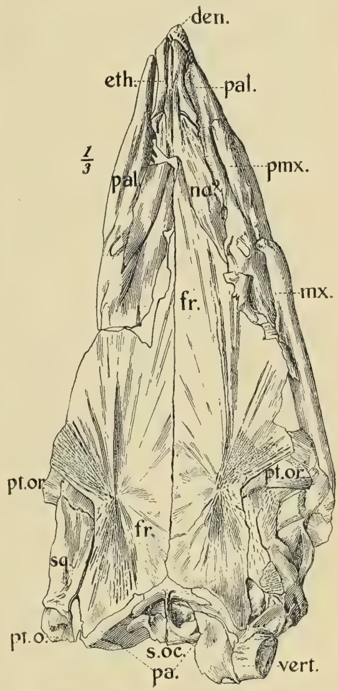

Fig. 69. *Empo nepaholica* Cope. No. 2522. × ⅓. Upper view of skull. *den.*, dentary; *eth.*, ethmoid; *fr.*, frontal; *mx.*, maxilla; *pa.*, parietal; *pal.*, palatine; *pmx.*, premaxilla; *pt. o.*, pterotic; *pt. or.*, postorbital; *s. oc.*, supraoccipital; *sq.*, squamosal; *vert.*, vertebra.

intervening between the epiotic and pterotic processes. There appear to be good reasons for drawing as we have, the lateral boundaries of the frontals; but the suture between the squamosal, *sq.*, and the postorbital, *pt. or.*, cannot be determined. The frontals extend far forward, so that they occupy by far the greatest portion of the upper surface of the skull. In the median line in front is the ethmoid, *eth.* The exact limits of this have not been determined. Posteriorly it expands and it appears to divide, sending a branch, *na?*, backward close to the mesial border of each premaxilla; but it is more probable that these lateral branches are distinct bones, the nasals. The premaxilla, *pmx.*, is a thin, elongated, sculptured bone, having small teeth along the lower border, except in front. It is applied closely to the palatine. Its teeth appear to have been directed forward. This is shown in Figure 70, *pmx.*, and the same appearance is presented by so many specimens that this position of the teeth appears to be the normal one.

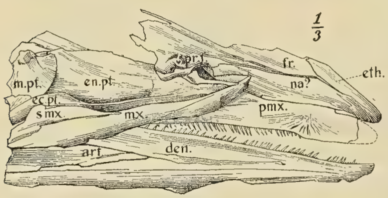

Fig. 70. *Empo nepaholica* Cope. No. 1776. × $\frac{1}{3}$. Part of skull, lateral view. *art.*, articular; *den.*, dentary; *ec.pt.*, ectopterygoid; *en.pt.*, entopterygoid; *eth.*, ethmoid; *fr.*, frontal; *m.pt.*, metapterygoid; *mx.*, maxilla; *na?*, nasal?: *pa.*, parietal; *pmx.*, premaxilla; *pt.o.*, postorbital; *smx.*, supramaxilla.

The maxilla, Figs. 69, 70, *mx.*, is a long, compressed, toothless bone which forms the posterior border of the mouth. Its anterior end overlaps for a long distance the premaxilla, its extremity in both the specimens figured here rising above the upper border of the premaxilla. The same position is shown in the skull figured by Loomis. Figure 71, No. 1969, shows the skull seen from below. The parasphenoid is very broad in front. It has possessed no teeth. The articular surface for the hyomandibular is short. The vomer does not appear in this specimen. It is the bone which Cope called and figured with doubt a pharyngeal. Stewart calls it the ethmoid. It is possibly consolidated with the ethmoid, but certainly both bones are represented. It possesses a varying number, one to four, of rows of teeth. Various specimens indicate that other

bones within the mouth were furnished with small teeth, but which they are has not been accurately determined. It appears likely that the ectopterygoid had minute teeth on its surface and some larger ones near one border.

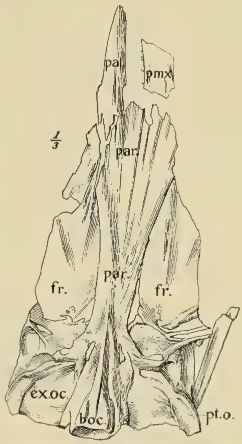

Fig. 71. *Empo nepaholica* Cope. No. 1969. × ⅓. Skull from below. *b. oc.*, basioccipital; *ex. oc.*, exoccipital; *fr.*, frontal: *pa.*, parietal: *pmx.*, premaxilla; *pt. o.*, pterotic.

I have had the opportunity of studying No. 4186 of the U. S. National Museum. In this the cleithrum has its external face presented. The first ray of the pectoral is segmented transversely, and was not a spine. Its anterior border is furnished with square notches and teeth, as is seen in Cope's work, pl. lii, fig. 1. On lifting the cleithrum from its bed the base of the fin is seen more distinctly. Besides the first ray about seven others are present. The precoracoid is present and is somewhat larger than in a salmon which has a jaw two-thirds as long as that of the fish here described. A portion of the coracoid is present and perhaps some of the scapula. The presence of the precoracoid fixes the position of the fish among the Isospondyli.

In No. 4719 of the U. S. National Museum there is a series of 25 vertebræ, together with ribs and the supports of the pelvic fins. Of these, apparently 10 belong to the caudal region, possibly only 9. Many ribs are present and several of them in their natural relation with the vertebræ. They are strongly developed, broad, and with much broadened heads. They resemble those of the common carp. They have been attached to distinct parapophyses. In some cases the latter have been freed by maceration and disturbance, and falling out have left long and deep cavities along the sides of the vertebræ. The hæmal arches of the tail region are apparently consolidated with their corresponding vertebral centra.

The supports of the pelvic fins are preserved and a portion of one fin (Fig. 72). It seems probable that the fin supports

have not been removed from their natural position. If so the base of the fin is placed between the 5th and 6th vertebræ in front of the first caudal. The fin itself is overlaid with fragments of ribs, so that the number of its rays cannot be accurately determined, but there were at least eight of them, the most anterior one being apparently rudimentary.

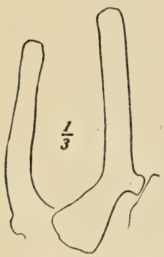

Fig. 72. *Empo nepaholica* Cope. No. 4719. U. S. Nat. Mus. × ⅓. Supports of ventral fins.

At the upper ends of the 4th and 5th caudal vertebræ are two bones which resemble interneurals with enlarged upper ends. They may represent the supports of the dorsal fin. They are rather weak and may be the more posterior ones of the series. In the region of the three or four most anterior hæmal arches are slender bones which may have been the supports of the anal fin.

No. 2032 of the American Museum of Natural History furnishes most of the tail fin (Pl. I, Fig. 4). The principal rays are large and coarsely segmented, but distally the rays divide into extremely fine filaments. The lobes of this fin were probably about 175 mm. in length.

The following fishes, as well as *Spaniodon simus*, described on page 47 were, as we learn from Prof. Cope (Bull. U. S. Geol. and Geog. Surv. Terrs., IV, 1878, p. 66), collected by Dr. F. V. Hayden in the "Niobrara Cretaceous of Dakota." No more accurate information has been afforded us regarding the locality where these specimens were found; but on several of the blocks of soft limestone, on which these fishes are preserved, some person has written in lead pencil the words "Yankton, Neb." From this label we may be quite sure that the specimens were found in the region of Yankton, South Dakota. We know likewise that the Niobrara deposits are abundantly developed in that region.

These fishes are of great interest from the fact that they belong to genera found in Upper Cretaceous deposits at Mount Lebanon, in Syria, or to genera very closely related to those of the latter region. It is greatly to be desired that further search shall be made in the country about Yankton for more

satisfactory specimens of those described by Cope, and for other species which may be yet unknown. That fishes are abundant in the soft limestone whence Dr. Hayden obtained his specimens, is shown by Plate V, which reveals three types on one side of a block, while a fourth type is found on the other side, besides a part of a large undescribed fish.

The figures of the species furnished on the plates are of the natural size and may be of some value in identifying other specimens, but they are difficult subjects to illustrate.

DERCETIDÆ.

Triænaspis *Cope.*

This genus was established by Cope in the 'Bulletin of the U. S. Geological and Geographical Survey of the Territories,' Volume IV, 1878, page 67. The type is *T. virgulatus* Cope. Dr. A. Smith Woodward unites the genus with *Leptotrachelus*, but the present writer is inclined, for the present, to regard it as distinct on account of the backward position of the ventral fins and the relatively short head. The type of the genus *Leptotrachelus*, *L. armatus*, possesses a dorsal fin of apparently about 12 rays, with the ventrals beneath the front of this dorsal. In *Triænaspis* the dorsal is still shorter, not having beyond 10 rays, and the ventrals are placed a distance behind the origin of the dorsal equal to one-third of the distance from the head to the dorsal.

Triænaspis virgulatus *Cope.*

PLATE V, FIG. 1.

Triænaspis virgulatus COPE (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV, 1878, p. 67. — HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 397.

Leptotrachelus virgulatus WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 187.

Of this species Professor Cope possessed, so far as can be determined, only the specimen here figured (Pl. V, Fig. 1) and a fragment of another. The present number of the type

is 2516. The describer concluded that the anal fin was absent in the species, but the present writer finds no warrant in the specimens for making any statements regarding this fin. The length of the head, including the opercular apparatus, is contained in the distance from the end of the operculum to the beginning of the dorsal fin something over one and one-half times: The head has not been prolonged into a beak such as we find in the species of *Leptotrachelus*.

Leptotrachelus longipinnis *Cope*.

Plate IV, Fig. 3, and Plate V, Fig. 4.

Leptotrachelus longipinnis Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV, 1878, p. 68. — Williston (S. W.), Kansas Univ. Quart., VIII, 1899, p. 115; Univ. Geol. Surv. Kansas, VI, 1900, p. 382. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 187. —Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 397.

Of this species Cope possessed two specimens. Of these his "No. 1" bears the Museum's catalogue number 2521 (Pl. V, Fig. 4) while his "No. 2" has the number 2520 (Pl. IV, Fig. 3). The former displays indistinctly the head, with its long beak, the neck consisting of much elongated vertebræ, the rays of the dorsal fin, and the ventral fins. Under a lens traces of the pectoral fin may be found close to the head. The other specimen shows more distinctly the dorsal and ventral fins, and some ribs, triradiate scales, and longitudinally directed hair-like bones in front of the dorsal. In No. 2521 a considerable part of the bones of the beak have been flaked away, leaving only their impression on the matrix. The letters *sn* indicate approximately the end of this beak. Pl. V, Fig. 4 shows the vertebræ of the neck forming a curve at the left of the head. Above and at the left of this curve is a blotch formed by the rays of another fish.

Besides the American species, six others may be recognized, as follows: *L. armatus* Marck and *L. sagittatus* Marck, from the Upper Cretaceous of Westphalia, *L. triqueter* Pictet, *L. gracilis* Davis, *L. hakelensis* Pictet and Humbert, all from the

Upper Cretaceous of Mount Lebanon, and *L. elongatus* (Agassiz), from the Senonian and Turonian of England.

It seems not unlikely that of the species of *Leptotrachelus* those having a long dorsal fin, *L. triqueter*, *L. longipinnis*, and *L. gracilis*, will have to be separated as a distinct genus, while *L. armatus* and *L. hakelensis* will be retained in *Leptotrachelus*.

MYCTOPHIDÆ.

Myctophidæ Jorlan and Evermann, Fishes of North and Middle America, 1896, p. 550.
Scopelidæ of most authors.

Leptosomus *Marck.*

To this genus the present writer assigns the species from the Niobrara of South Dakota, which Cope placed in the genus *Sardinius*. The latter genus has the scales pectinated, the pectoral fins with about 18 rays, the anal with about 20 rays, and about 45 vertebræ. The American species agree with *Leptosomus* in having, so far as can be determined, cycloid scales, narrow pectorals, a short anal, and about 30 vertebræ. Cope regarded *Leptosomus* as a synonym of *Sardinius*, but Woodward properly separates it. The author last named recognizes four species of this genus, *L. guestphalicus* Marck and *L. elongatus* Marck, both from the Upper Cretaceous of Westphalia, and *L. macrourus* Pictet and Humbert, and *L. minimus* (Agassiz), both from the Upper Cretaceous of Mount Lebanon.

Leptosomus nasutulus (*Cope*).

Plate IV, Figs. 4 and 5.

Sardinius nasutulus Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV, 1878, p. 70. — Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 248. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 391.

Of this species there are in this Museum three specimens as follows: The type No. 2512 (Pl. IV, Fig. 4), No. 2513 (Pl. IV, Fig. 5), and No. 2523.

Most of Cope's measurements are taken from the type, but the distance from the snout to the base of the ventral fins is taken from No. 2513. This was necessary because in the type the ventrals have been washed forward to beneath the lower jaw, as may be seen from the figure.

On the block containing No. 2523 are scratched in pencil the words "Yankton, Neb." The other specimens are without doubt from the same locality.

Leptosomus lineatus (*Cope*).

PLATE IV. FIG. 6 AND PLATE V. FIG. 2.

Sardinius lineatus COPE (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV., 1878, p. 71. — WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 248. — HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 391.

This species was based on two specimens, No. 2538 (Pl. IV, Fig. 6) and No. 2511 (Pl. V, Fig. 2). The former specimen displays the body as far back as the rear of the dorsal fin; the latter specimen shows the hinder half far enough forward to show the tips of the ventral fins; but neither specimen shows both the dorsal and the ventrals. Hence, the exact relation of these fins to each other can not be determined.

The block on which No. 2538 is preserved, and which also bears *Spaniodon simus*, is marked "Yankton, Neb."

Leptosomus percrassus (*Cope*).

PLATE V, FIG. 3.

Sardinius percrassus COPE (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV, 1878, p. 72. — WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 248. — HAY (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 391.

This species is represented by a single specimen, No. 2510 (Pl. V, Fig. 3). It differs from the other species in having a much deeper body. Although there is no record either on the block bearing this species, or in Professor Cope's description, there can be do doubt that it came from the same

locality and deposit as the other species here recorded from South Dakota.

Sardinius? imbellis *sp. nov.*

Plate IV, Fig. 9.

The block of soft limestone which bears the type of Cope's *Sardinius nasutulus* presents also parts of two other small fishes which appear to be undescribed. One of these, No. 2550, lacks the head and the whole of the body above the vertebral column, except a portion of the upper lobe of the caudal fin. The other specimen, No. 2549, presents the body from the front of the dorsal fin to the extremity of the caudal. Perhaps it would be wise to refrain from describing these specimens, as Cope refrained. Nevertheless, they appear to differ from any species yet described and to furnish characters which will make it possible to recognize other specimens when they shall be found. So far as can be determined from the remains at hand, the species belongs to the Myctophidæ, and it stands nearer to *Sardinius cordieri* than to any other related form. From *Sardinius* it appears to differ in having fewer vertebræ, fewer rays in most of the fins, in the position of the dorsal, and in the character of the scales. It appears safer, however, to await the finding of additional and better materials before proposing a new generic name. The longitudinally divided specimen, No. 2550 (Pl. IV, Fig. 9), is taken as the type.

From the caudal fin to the insertion of the pectoral 36 vertebræ are counted. The whole number probably has been about 40. Of these, 15 appear to have belonged to the caudal region. The ribs are slender. The pectoral fin is broad and consists of 15 rays; but it is rather short and lacks somewhat of reaching the ventrals. The latter fins are pressed down, the one on the other, so that the exact number of rays cannot be determined. Six may be counted. These fins are placed nearer to the pectorals than to the anal. The dorsal is missing in the type. The anal has a long basis and consists of 15 or 16 rays. The caudal is deeply forked. No evidences

appear of any pectination of the scales. The body has been rather deep.

The second specimen presents an anal fin of 16 rays. In front of it is the dorsal, which appears to be supported by 12 interneurals. The front of the dorsal begins above the tenth vertebra in front of the origin of the anal. Three or four neural arches and two or three hæmal arches at the base of the caudal are expanded somewhat. Besides the slender neural arches and ribs, there are numerous fine intermuscular bones. No part of the ventrals appears in this specimen. Assuming both fishes to belong to the same species, it is evident that the dorsal fin is placed in the interval between the ventral and the anal fins. The whole length of the type has been close to 65 mm.

Niobrara Cretaceous, region of Yankton, South Dakota.

Rhinellus *Agassiz.*

Dr. A. .S. Woodward has properly, as it appears to the writer, reduced Cope's genus *Ichthyotringa* to a synonym of *Rhinellus* Agassiz. The scales along the lateral line of the American species also may have been somewhat thickened, and the dorsal fin has about the same number of rays as in *R. furcatus*, the type of the genus.

Rhinellus tenuirostris (*Cope*).

Plate IV, Figs. 7 and 8.

Ichthyotringa tenuirostris Cope (E. D.), Bull. U. S. Geol. and Geog. Surv. Terrs. IV, 1878, p. 69. — Hay (O. P.), Bibliog. and Cat. Foss. Vert. N. A. 1902, p. 297.

Rhinellus tenuirostris Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 269.

This species is based on two specimens, No. 2514, the type (Pl. IV, Fig. 7), and No. 2515 (Pl. IV, Fig. 8). The former shows the head, with its long beak, and the body above the vertebral column as far backward as the rear of the dorsal fin. The latter, a small fish, displays the anterior portion of the body from below. Both pectoral and both ventral fins are presented.

The block on which this specimen is found is marked "Yankton, Neb." Of the other valid species of this genus *R. furcatus* Agassiz is found in the Upper Cretaceous of Mount Lebanon and Westphalia; *R. ferox* Davis and *R. damoni* Davis, in the Upper Cretaceous of Mount Lebanon.

Explanation of the abbreviations employed in the figures and on the plates to indicate the names of the bones and other structures.

a. f. = anal fin,
als. = alisphenoid,
ang. = angular,
a. r. = anal fin rays,
art. = articular,
art. s. = articular surface,
bas. = baseosts,
b. br. = basibranchial,
b. oc. = basioccipital,
cl. = cleithrum,
cor. = coracoid,
den. = dentary,
d. f. = dorsal fin,
d. r. = dorsal fin rays,
ec. pt. = ectopterygoid,
en. pt. = entopterygoid,
ep. o. = epiotic,
eth. = ethmoid,
ex. oc. = exoccipital,
fr. = frontal,
gl. h. = glossohyal,
i. h. = interhæmals,
i. n. = interneurals
i. op. = interoperculum,
m. pt. = metapterygoid,
mx. = maxilla,
na. = nasal,
op. = operculum,
op. o. = opisthotic,
os. = orbitosphenoid,
pa. = parietal,
pal. = palatine,
par. = parasphenoid,
p. cor. = precoracoid,
pct. = pectoral fin,
p. f. = pectoral fin,
pmx. = premaxilla,
p. op. = preoperculum,
pr. f. = prefrontal,
pro. = proötic,
p. sp. = presphenoid,
pt. f. = postfrontal,
pt. o. = pterotic,
pt. or. = postorbital,
sc. = scapula,
smx. = supramaxilla,
sn. = tip of snout,
s. oc. = supraoccipital,
s. op. = suboperculum,
s. or. = suborbital,
sq. = squamosal,
su. cl. = supracleithrum,
vert. = vertebra,
v. f. = ventral fin,
vom. = vomer,
vom. t. = vomerine tooth,
v. r. = ventral fin rays.

EXPLANATION OF PLATE I.

Fig. 1.—*Protosphyræna perniciosa* (Cope). Page 9. Pectoral fin. × $\frac{1}{4}$. No. 1901.

Fig. 2.—*Protosphyræna tenuis* Loomis. Page 15. Pectoral fin. × $\frac{1}{4}$. No. 205.

Fig. 3.—*Protosphyræna tenuis* Loomis. Page 16. Distal end of pectoral fin. × $\frac{1}{2}$. No. 1620.

Fig. 4.—*Empo nepaholica* Cope. Page 88. Part of caudal fin. × $\frac{1}{2}$. No. 2032.

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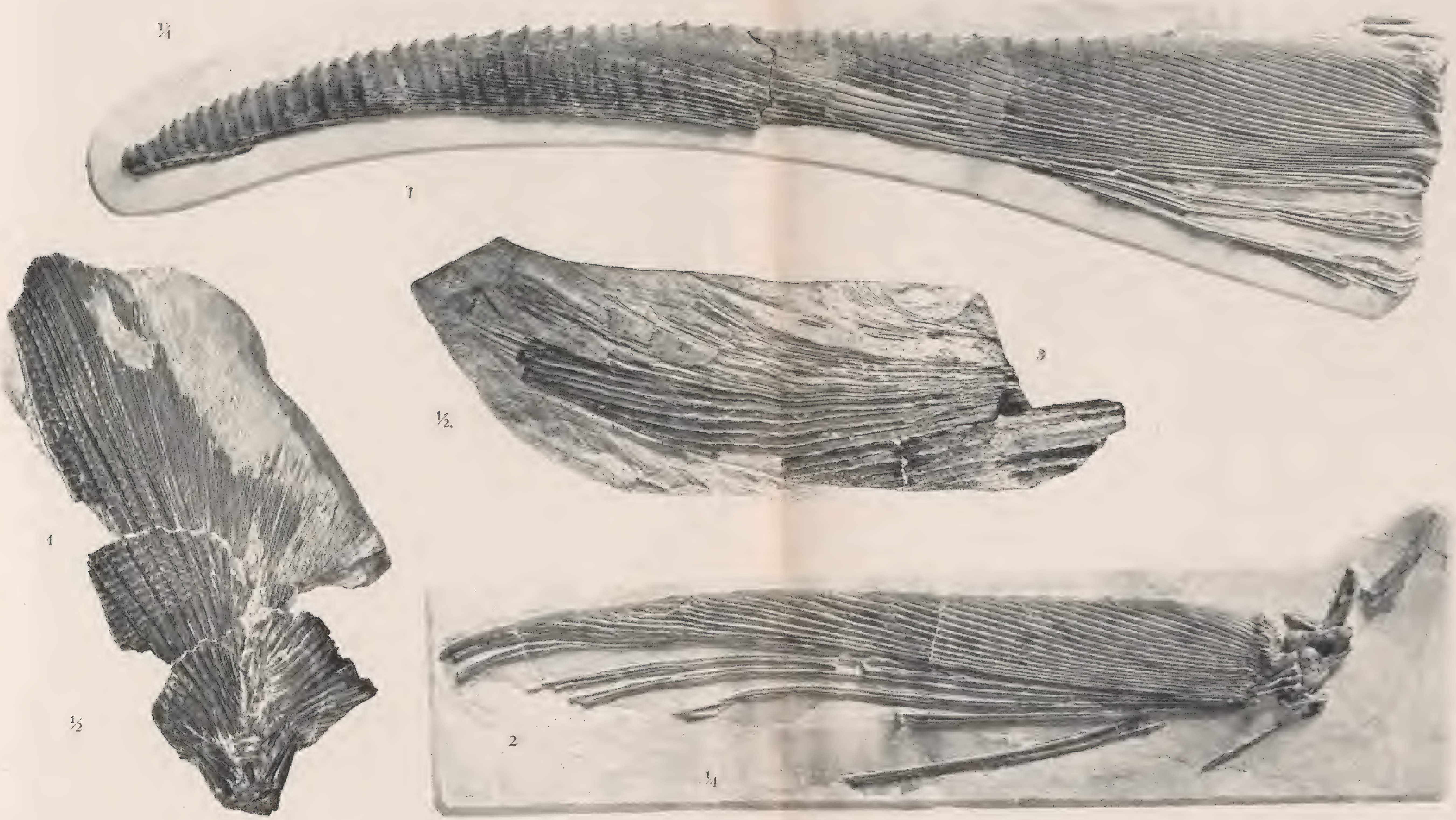
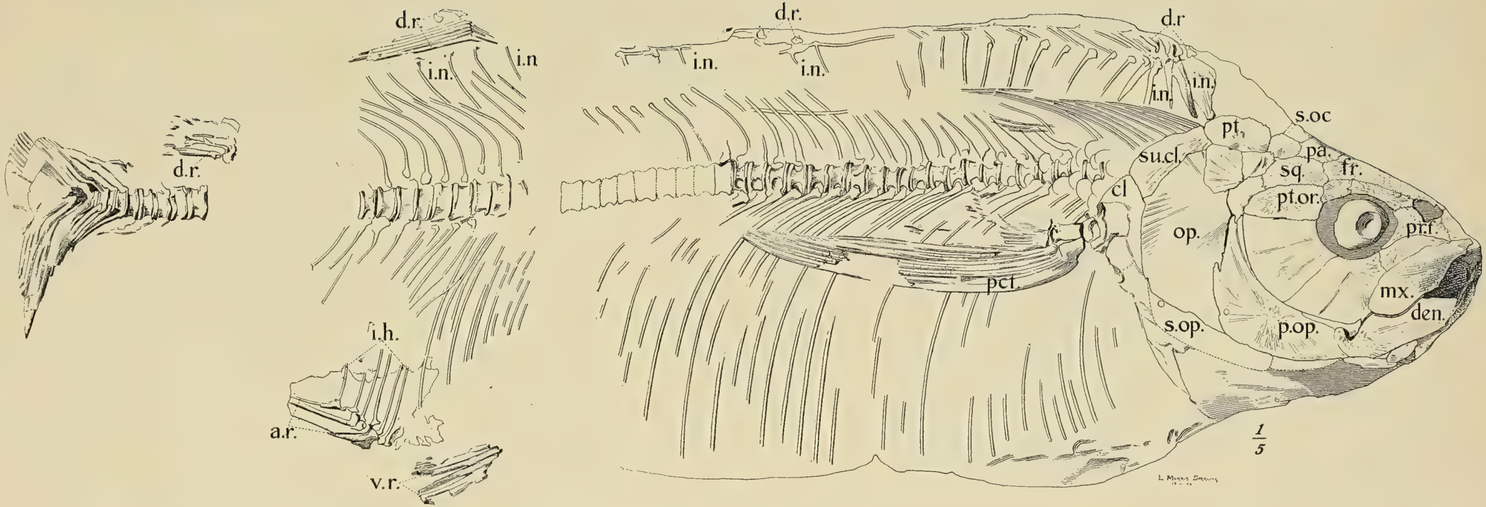


Protosphyræna and Empo.



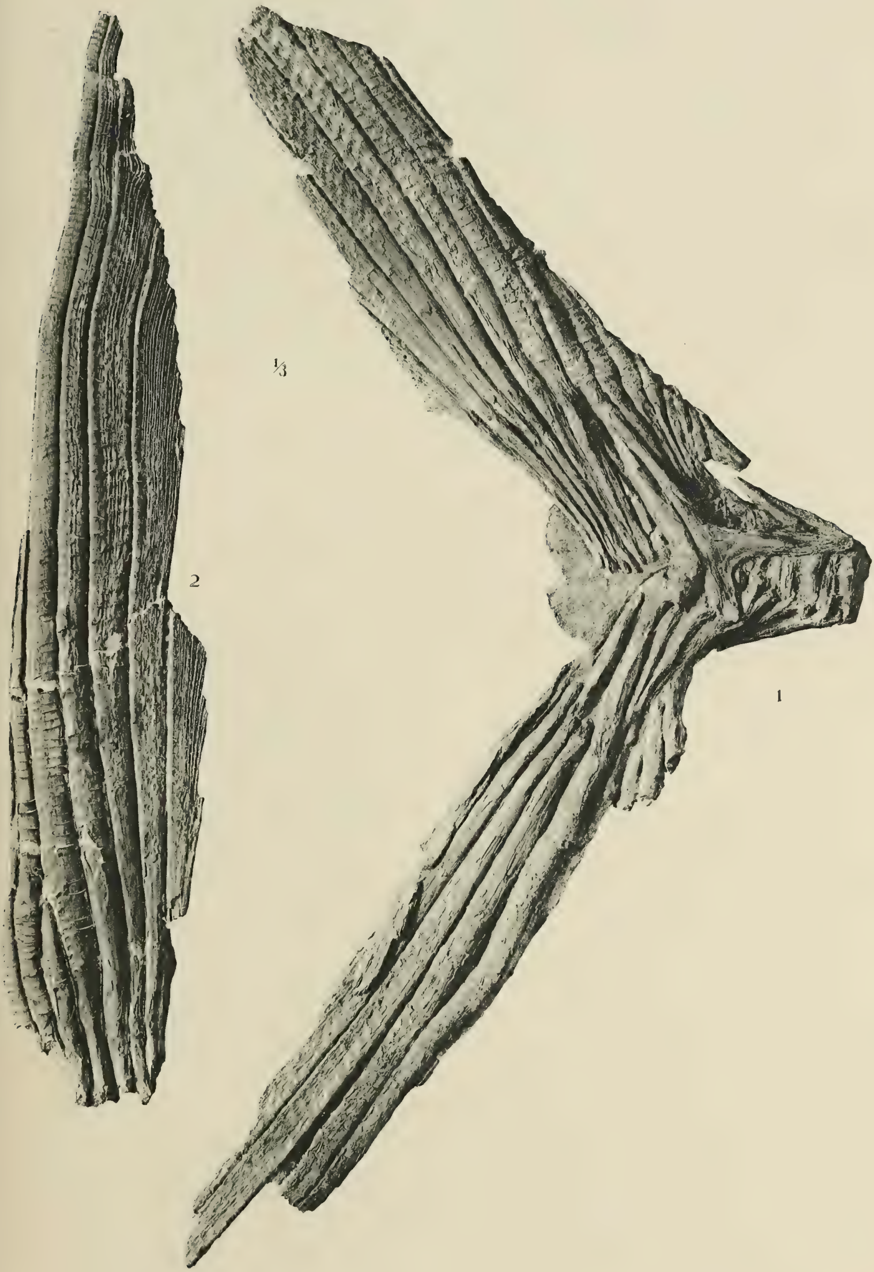
ANOGMIUS ARATUS COPE.

Anogmius aratus Cope. No. 2403. × 1/5. Type. *a. r.*, rays of anal fin; *cl.*, cleithrum; *d. r.*, rays of dorsal fin; *den.*, dentary; *fr.*, frontal; *i. h.*, interhæmal bones; *i.n.*, interneural bones; *mx.*, maxilla; *op.*, opercular; *pa.*, parietal; *pct.*, pectoral fin; *p op.*, preoperculum; *pr. f.*, prefrontal; *pt.*, post-temporal; *pt. or.*, postorbital; *s. oc.*, supraoccipital; *s. op.*, suboperculum; *sq.*, squamosal; *su. cl.*, supracleithrum; *v. r.*, rays of ventral fin.

PACHYRHIZODUS.

EXPLANATION OF PLATE III.

Pachyrhizodus caninus Cope. Page 63.
Fig. 1.—Caudal fin and vertebræ. $\times \frac{1}{3}$. No. 1900.
Fig. 2.—One lobe of caudal fin. $\times \frac{1}{3}$. No. 1658.



PACHYRHIZODUS.

CRETACEOUS FISHES.

EXPLANATION OF PLATE IV.

Fig. 1.—*Spaniodon simus* Cope. Page 47. Nearly complete fish. Type. × 1/1. No. 2508. *a. f.*, anal fin; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

Fig. 2.—*Spaniodon simus* Cope. Page 47. Anterior half of fish. Paratype. × 1/1. No. 2509. *den.*, dentary; *p. f.*, pectoral fin; *pmx.*, premaxilla.

Fig. 3.—*Leptotrachelus longipinnis* Cope. Page 90. Part of trunk. Cotype. × 1/1. No. 2520. *d. f.*, dorsal fin; *v. f.*, ventral fin.

Fig. 4.—*Leptosomus nasutulus* (Cope). Page 91. Nearly complete fish. Type. × 1/1. No. 2512. *a. f.*, anal fin; *d. f.*, dorsal fin; *v. f.*, ventral fin (displaced).

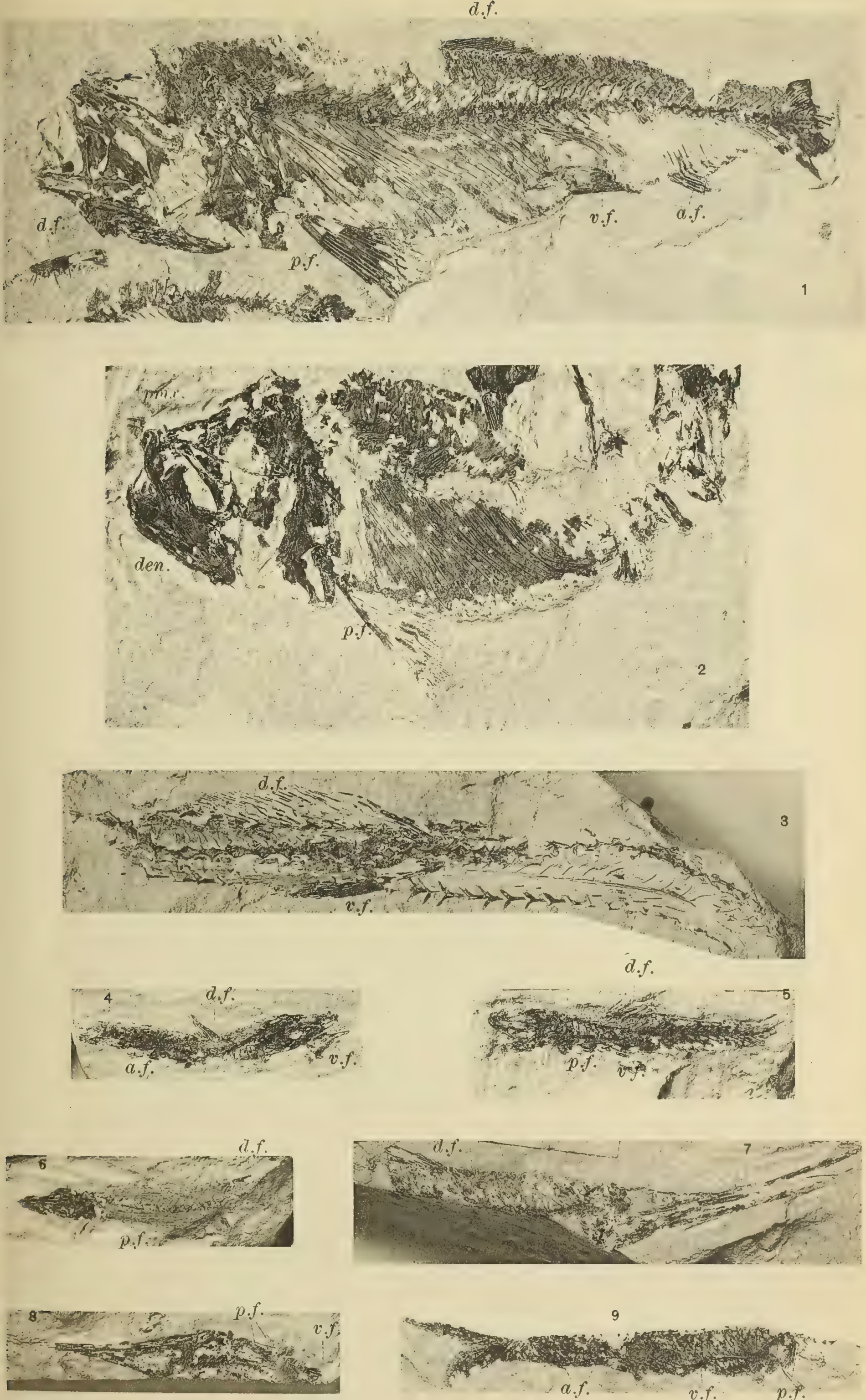
Fig. 5.—*Leptosomus nasutulus* (Cope). Page 91. Nearly complete fish. × 1/1. No. 2513. *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

Fig. 6.—*Leptosomus lineatus* (Cope). Page 92. Fish with tail missing. Cotype. × 1/1. No. 2538. *d. f.*, dorsal fin; *v. f.*, ventral fin.

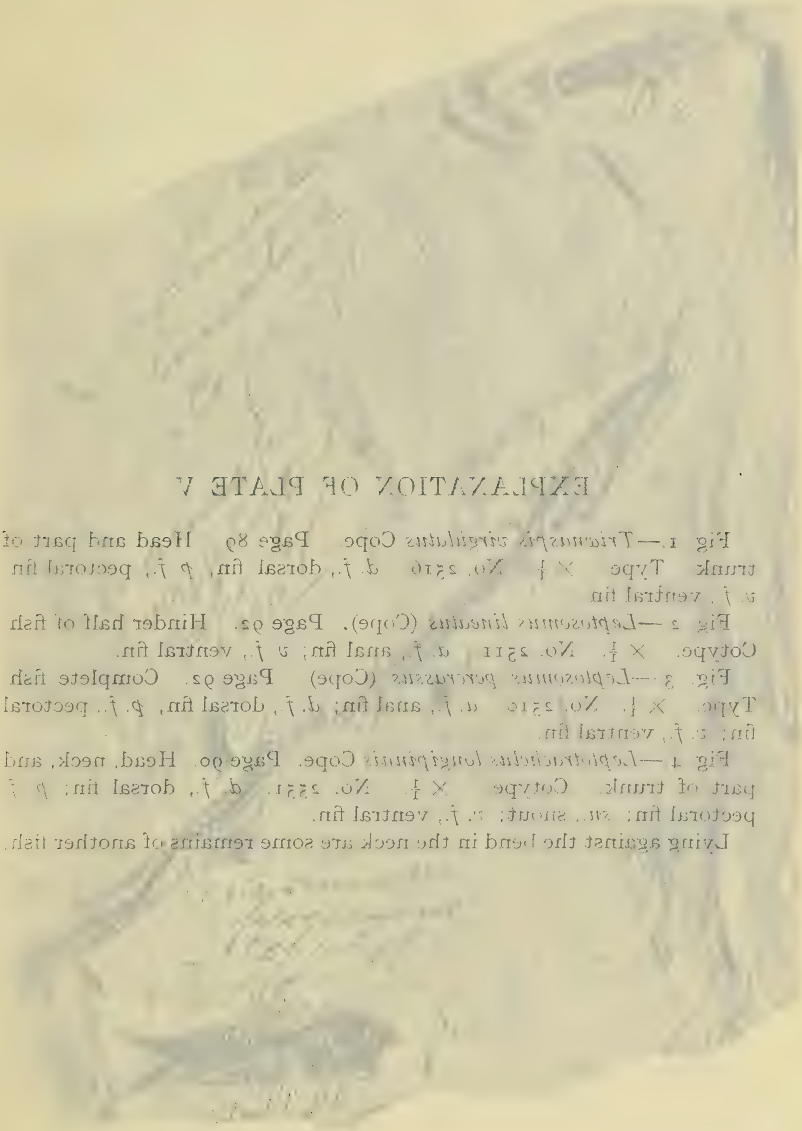
Fig. 7.—*Rhinellus tenuirostris* Cope. Page 94. Head and part of trunk. Cotype. × 1/1. No. 2514. *d. f.*, dorsal fin.

Fig. 8.—*Rhinellus tenuirostris* Cope. Page 94. Head and part of trunk. Cotype. × 1/1. No. 2515. *p. f.*, pectoral fin; *v. f.*, ventral fin.

Fig. 9.—*Sardinius ? imbellis* Hay. Page 93. Lower half of fish. Type. × 1/1. No. 2550. *a. f.*, anal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.



CRETACEOUS FISHES.



EXPLANATION OF PLATE V.

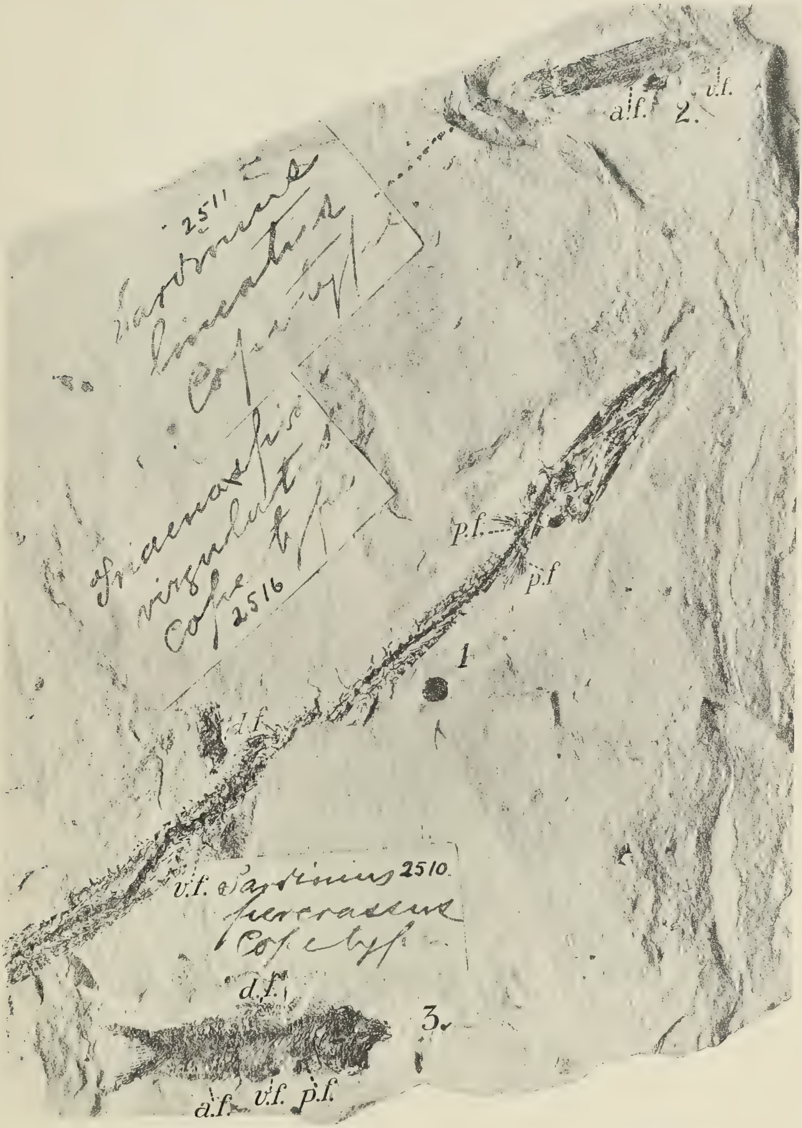
Fig. 1.—*Tricænaspis virgulatus* Cope. Page 89. Head and part of trunk. Type. × 1/1. No, 2516. *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

Fig. 2.—*Leptosomus lineatus* (Cope). Page 92. Hinder half of fish. Cotype. × 1/1. No. 2511. *a. f.*, anal fin; *v. f.*, ventral fin.

Fig. 3.—*Leptosomus percrassus* (Cope). Page 92. Complete fish. Type. × 1/1. No. 2510. *a. f.*, anal fin; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

Fig. 4.—*Leptotrachelus longipinnis* Cope. Page 90. Head, neck, and part of trunk. Cotype. × 1/1. No. 2551. *d. f.*, dorsal fin; *p. f.* pectoral fin; *sn.*, snout; *v. f.*, ventral fin.

Lying against the bend in the neck are some remains of another fish.



CRETACEOUS FISHES

Article II. — NOTICE OF A SPECIES OF ACIDASPIS FROM A BOULDER OF MARCELLUS SHALE, FOUND IN DRIFT, AT WEST BLOOMFIELD, NEW JERSEY.

By C. H. Hitchcock.

Plate VI.

At the Troy meeting of the American Association for the Advancement of Science I offered a paper entitled 'Description of a new Trilobite from New Jersey,' which was not printed in the 'Proceedings' (Vol. XIX) but the title was given on page 362 of that volume.

The further description and illustration of the species has been deferred until the present time, owing to unavoidable circumstances, but I now present as full a description as its condition will permit, together with photographic illustrations, twice natural size.

The specimen lies on the surface of a limestone boulder of quadrangular form found in West Bloomfield, New Jersey, by the late Rev. E. Seymour, which was identified by Mr. R. P. Whitfield, when shown him at the meeting in Troy, as belonging to the Marcellus shale, from the occurrence of a specimen of *Leiorhynchus limitaris* on the same surface with the trilobite, and fragments of a second specimen of the same species of trilobite. Professor James Hall also referred this specimen to the Marcellus shale, and said it was an undescribed species.

Acidaspis whitfieldi, sp. nov.

Plate VI.

Entire carapace 2.3 centimeters in length; upper part of thoracic axis, 4 mm. wide, the axis marked by nine thoracic rings or segments; head shield 8 mm. long, by 13 mm. wide, exclusive of the cheek spines fringing the sides of the shield.

Glabella very tuberculose, but its crushed condition renders it impossible of description more than that the surface has been covered by small pustules, especially on the front margin and on the cheek borders.

Movable cheeks semilunate, armed on the outer middle margin with

slender spines which arch gently forward, decreasing in length anteriorly and finally represented by nodes on the front margin. No spine is visible at the posterior genal angle, but the border appears to round inward to the posterior border of the head shield.

Thorax composed of nine segments, each of which terminate on the margins of the body in a long backwardly curved spine, those of the fifth being much the longest; those of the other joints shortening gradually behind and in front of the fifth. Several of these spines are set on their lateral faces with many smaller subspines; and the anterior member of each segment of at least the four posterior joints or rings gives origin, at its extremity, to an additional organ which is closely set with lateral spines.

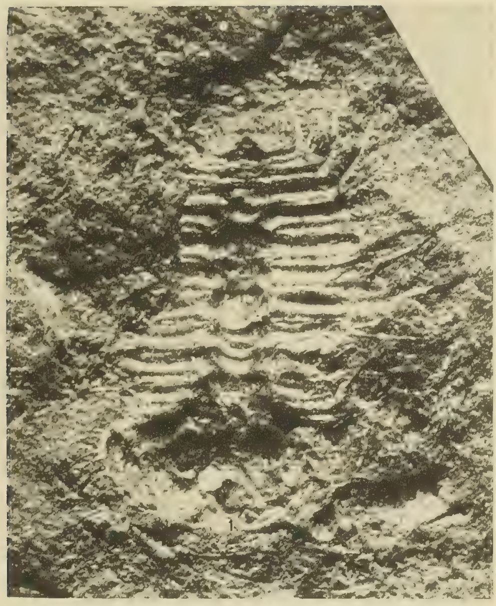
Pygidium very small, exceedingly short, axial lobe narrow but obtuse, the extremity bearing two minute sharp tubercles, marked by only a single axial ring. Lateral lobes flat, marked by a single rib which crosses them at right angles to the axial lobe and terminates on the margin in a single large, slightly curved spine, the largest on the pygidial plate. In front of this spine, on each side, there are three shorter spines, and ten or perhaps eleven still smaller spines on the posterior margin between the longer ones terminating the larger rib which crossed the plate from the axial lobe.

The surface of the specimen bears evidence of having been roughly pustulose with rows of nodes along all the principal parts.

Locality and Geological Position.—Near West Bloomfield, New Jersey, in drift.

The source of this boulder is probably the range of Hamilton rocks running N. E. by S. W. from Greenwood Lake, N. J.

There is no species of the genus *Acidaspis* in American rocks that approaches very nearly to this one. The nearest is *A. tuberculata* Conrad, from the Lower Helderberg Group in Albany Co., N. Y., illustrated in Vol. III, Pal. N. Y., Plate 79. *A. mira* Barrande, figured on Plate 39, figs. 1–11, of the Système Silurien de la Bohème, bears a rather close resemblance to this, being of the same type, but it is rather more complicated in the distribution of the spines.



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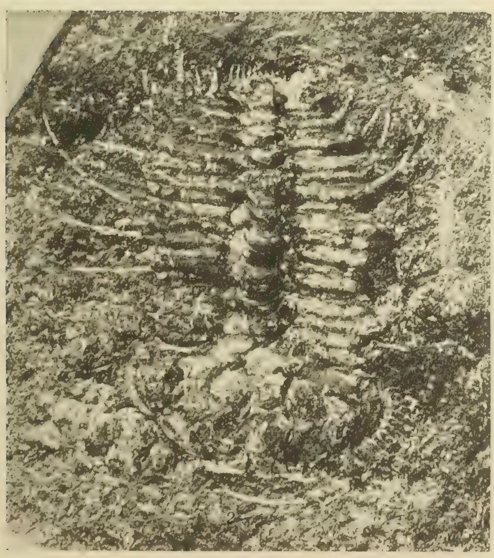


2.

ACIDASPIS WHITFIELDI HITCHCOCK.

Article III. — DESCRIPTION OF A NEW SPECIES OF SIGMODON FROM ECUADOR.

By J. A. Allen.

The material on which the present species is based was kindly sent to me for determination by Mr. Oldfield Thomas, Curator of Mammals at the British Museum, with permission to describe it if new, and to retain the duplicates for this Museum. While the species represented by this material is nearly related to *Sigmodon simonsi*, it is well distinguished by certain cranial differences and by the less intense fulvous suffusion of the general pelage, especially that of the ventral surface.

Sigmondon puna, sp. nov.

Type, No. 30, female ad., Coll. Perry O. Simons (British Museum), Puná, Puná Island, Ecuador, Nov. 10, 1898; altitude 10 m.

Similar to *Sigmodon simonsi* Allen (this Bull., XIV, 1901, p. 40), from Eten, Peru, but less suffused with buff, especially on the ventral surface, which is only slightly or not at all tinged with pale buff instead of being heavily washed with clear deep buff; fore and hind feet grayer, and eye-ring paler. Skull with the anteorbital foramen much broader, and hence larger and differently shaped; the bullæ considerably more swollen, the dentition weaker, and the rostral portion of the skull shorter.

Measurements.—Head and body, 145; tail, 98; hind foot, 29; ear, 21 mm. Nine adults average: Head and body, 145 (140–160); tail, 98 (92–100, with one specimen 160); hind foot, 29 (28–30); ear, 20.6 (19–22).

Skull.—Type: Total length, 34; basal length, 30; palatal length, 16; length of nasals, 12; zygomatic breadth, 20; mastoid breadth, 14; interorbital constriction, 5; upper toothrow, 7. Six adult skulls range in total length from 33–36, and in zygomatic breadth from 18.5–20.

Sigmodon puna is represented by a series of 15 specimens taken at Puná, Puná Island, during the first half of November, 1898, they being among the first specimens collected by the late Perry O. Simons on the west coast of South America.

About one half of the series are fully adult, with the teeth more or less worn; the others are 'young adults,' but none are very young, nor are any very old. To this species are referred four others collected at Guayaquil, on the mainland. They present the same cranial characters as the Puná examples, but three of them are much darker above and more grayish white below than the Puná series. As, however, one of the latter is indistinguishable from the three dark Guayaquil specimens, and one of the Guayaquil specimens is like the more buffy examples of the Puná series, this color difference seems to indicate two color phases—a gray and a slightly rufescent phase—rather than two geographical forms.

Article IV.— REPORT ON THE MAMMALS COLLECTED IN NORTHEASTERN SIBERIA BY THE JESUP NORTH PACIFIC EXPEDITION, WITH ITINERARY AND FIELD NOTES, BY N. G. BUXTON.

By J. A. Allen.

CONTENTS.

Introduction.

This is the first of a series of papers on the zoölogical results of the Siberian Division of the Jesup North Pacific Expedition. Other reports will follow on the birds and fishes.

The natural history collections were made principally by Mr. N. G. Buxton, of Johnstown, Ohio, whose experience in arctic collecting at Point Barrow, Alaska, on the McIlhenny Expedition, in 1897–98, had especially fitted him for his work in Siberia. His 'Itinerary,' given below, fully describes the nature of the country visited, including its climatic and topographic features, while his field notes, given in connection with the species to which they relate, add greatly to the value of the present paper. Mr. Buxton collected mainly in the neighborhood of Gichiga, on the west coast of the Okhotsk Sea, but also at Marcova, on the middle Anadyr River, 600 miles north of Gichiga, and at some other points. Mr. Buxton's zeal and industry are attested by the large number of specimens he obtained in a country where the fauna is meager and the season for field work is limited to a comparatively small portion of the year. The fine condition of the specimens is evidence of his skill and care as a collector.

The present paper includes not only the mammals collected by Mr. Buxton, but also those obtained by other members of the Siberian Expedition. These comprise a few collected on the lower Amoor River by Dr. Berthold Laufer, a few taken

at Vladivostok, many collected at Marcova by Messrs. Buxton, Bogoras, and Axelrod, a considerable number from near the mouth of the Anadyr River and at Indian Point, on the extreme northeastern coast of Siberia, collected by Mr. Bogoras, and a small but very interesting collection made near Verkhne Kolimsk, on the middle Kolyma River, by Mr. Jochelson.

This report is restricted to the material collected by the Jesup Siberian Expedition, and is in no sense intended as an exposition of the mammalian fauna of eastern Siberia.

In this connection I wish especially to acknowledge my indebtedness to Mr. Gerrit S. Miller, Jr., Curator of Mammals at the National Museum, not only in securing for me the loan of valuable material for comparison, but also for kind assistance and advice.

The species treated in the present paper number 35, of which 29 are represented by specimens, and 6 are presented simply on the basis of Mr. Buxton's field notes. The number of specimens of mammals in the collection is about 500. Several of the species here recorded appear to have hitherto escaped recognition. These, including two seals described in a previous paper[1] based primarily on the Buxton material, are the following:

Ochotona kalymensis.	Lemmus obensis chrysogaster.
Lepus gichiganus.	Phoca hispida gichigensis.
Citellus buxtoni.	Vulpes anadyrensis.
" stejnegeri.	Putorius pygmæus.
Evotomys jochelsoni.	Erinaceus orientalis.
" latastei, nom. nov.	Sorex buxtoni.

As would be naturally expected, the present investigation brings to light several new illustrations of the intimate relationship of the mammalian fauna of Siberia with that of Alaska. A small shrew (*Sorex buxtoni*, sp. nov.) finds its nearest relative in *Sorex pribilofensis* Merriam of the Pribilof Islands; the large spermophile of eastern Siberia finds its nearest ally in the *Citellus parryi* group of arctic and subarctic America, and not in *C. eversmanni* of the interior of Siberia. The small weasel of eastern Siberia proves not to

[1] This Bulletin, Vol. XVI, 1902, pp. 459–499, figs. 1–10; Dec. 12, 1902

be a member of the *Putorius nivalis* group, but a near relative of *P. rixosus* Bangs of arctic America. It is not surprising that some of the seals of the genus *Phoca* should be found to range along the coast of Siberia from Okhotsk Sea to Point Barrow, but it is interesting to note that these do not include the Pacific Coast Harbor Seal (*Phoca richardii*), and also that the Harp Seal (*Phoca grœnlandica*) does not pass through Bering Strait into Bering Sea, as formerly believed, its supposed records of occurrence here apparently resting on the misidentification of young males and females of *Histriophoca fasciata* for this species.[1]

It may be further noted that the skins of many fur-bearing animals are imported from Alaska into northeastern Siberia. Thus among a lot of peltries purchased at Indian Point (Chaplin Point of most maps), on the Chukchee Peninsula, by Mr. Bogoras and brought to the American Museum, are skins of the Lynx, Otter, Beaver, Red Fox (in its various phases), Arctic Fox, Blue Fox, and Sable, which are readily recognized by expert furriers as of Alaskan origin. Of course, none of these are formally included in the present report. Respecting the Beaver, I find the following in Mr. Buxton's notes. Mr. Buxton says: "I was assured by Mr. Sokolnikoff, as well as by many others, that there are no Beavers in northeastern Siberia, and that all the skins that one sees there are obtained from the American whaling fleet by the Chukchees, who in turn trade them to the Russians at Marcova and the settlements along the Kolyma River. They bring from ten to fifteen roubles each."

The external measurements given in this paper were taken from the fresh specimens by the collector, unless otherwise stated, and are expressed in millimeters. Mr. Buxton's field notes follow the technical matter under each species, and are placed in marks of quotation and followed by the initials, 'N. G. B.' In several instances some of his unpublished notes on mammals met with by him at Point Barrow are here inedited, on account of their special interest in the present connection.

[1] See this Bulletin, Vol. XVI, 1902, pp. 475-477.

Itinerary and General Description of the Country.

By N. G. Buxton.

On March 16, 1900, I received instructions at New York to proceed immediately to San Francisco, purchase my outfit, and be in readiness to sail with the Jesup North Pacific Expedition for northeastern Siberia on April 10, which had already been organized and equipped for an ethnological survey of that country.

Accordingly I left New York March 24, going by way of New Orleans and thence over the line of the Southern Pacific Railway Company, whose officials had kindly furnished me with transportation, and arrived at San Francisco April 1. Mr. W. Jochelson, leader of the expedition, and Mr. Bogoras came on the 9th, when it was decided that it would be impossible to get away on the 10th as we had expected. However, by the end of the following week we had so far completed our outfits and arranged the details necessarily incident to such an undertaking, that we engaged passage on the Oriental and Occidental Steamship Company's vessel 'Doric,' which sailed on the 17th. After an uneventful voyage of six days we sighted the Sandwich Islands, and that afternoon, April 23, rounded Diamond Head and docked at Honolulu. One day was spent here, when we resumed our journey, and on the 4th of May reached Yokohama, where we remained four days; we made Kobi on the 9th and Nagasaki on the morning of the 11th. We left the same day at midnight, on the Chinese Eastern Railway Company's steamer 'Mukden.' Fusan, on the Korean coast, was reached May 12, Gensan the 14th, and on the 16th we anchored in the harbor off Vladivostok.

According to our plans, Mr. Bogoras was to proceed north to the Gulf of Anadyr while Mr. Jochelson, Mr. Axelrod, whom we found here awaiting us, and myself were to go to Gichiga at the head of Okhotsk Sea. We found that the next vessel for the latter place would sail in about ten days, which was too soon for us, as we still had to get our official papers, buy our staple provisions and trading goods, complete our outfits, and

divide and repack the goods that had already been purchased in Europe. Mr. Bogoras was more fortunate, as the one vessel which visits the Anadyr country annually did not sail until June 14.

As the next vessel for Gichiga was not to sail until July 24, I had considerable time at my disposal, which I employed in making a collection of the fishes found in the harbor at Vladivostok and the Gulf of Peter the Great. There are no streams in the vicinity of Vladivostok where fresh-water fish could be taken, so on May 27 I went by train to Nikolsk and posted from there by telegas to Lake Khanka, a distance of ninety miles, arriving on the 29th. Governor Chichigoff had kindly wired the officials along the way of my coming, provided me with letters of introduction, and an official request for post-horses, so that notwithstanding my inability to speak the language I got along very well. At the lake I was entertained by Mr. Shubenko, who had two or three cabins there and employed twenty Korean fishermen during the summer and supplied the Nikolsk market with fresh fish. This lake is a shallow, gradually shoaling body of water, lying between 44° 30′ and 45° 30′ N. and 132° and 133° E. It is about 50 miles long, 40 miles wide, and 225 feet above sea-level, and is surrounded by extensive marshes which drain into the Sungari River, a tributary of the Amoor. Through the interest my host and his men took in my collection I was able to fill my tanks in one week and secure specimens of all the food fishes that occurred there at that season of the year, although the smaller and probably more interesting ones I did not get on account of the lack of necessary means. Early on the morning of June 5 the telega which I had ordered from Kamenribiloff, a post station one mile distant, called for me and after a wild, rough ride of six relays I reached Nikolsk at midnight and returned to Vladivostok the next day.

On June 18 the steamship company told us that a vessel would be despatched for Gichiga between the 20th and 28th of June, so we renewed our efforts to get everything in readiness, and felt hopeful of getting in the field before the short, northern summer had passed, when, on the 21st, rumors of the

Chinese trouble reached us. This caused the company to declare the sailing of this vessel off, and made them undecided about sending the one scheduled for July 24, as all ships were being pressed into the government transport service. Then followed for us an anxious and exciting month, as inhabitants of a Russian fortified port in active war times. Thousands of soldiers arrived daily from the interior and departed in transports for the front; missionaries and merchants came from Manchurian points up the Amoor River; the Chinese stopped work and fled the city; martial law was proclaimed, and commerce came almost to a standstill. Finally we were assured that the 'Khabarovsk' would leave July 23, and on that date our party took passage on it. Our course lay north along the coast between the mainland and Saghalin Island, and our voyage was without incident until the 28th, when we went aground in the shallow, tortuous channel off the mouth of the Amoor River. After waiting three days for an abatement of the wind and a high tide, the water-ballast tanks were pumped out and we floated again. August 2 we came to anchor in Udskoi Bay, back of Great Shantai Island, discharged a small amount of cargo for the little settlement there, and were soon under way again for Ayan.

The small number of sea-birds observed along the Siberian coast, as compared with the large number one encounters on the Alaska side in the same latitude, is very striking.

August 3.—Anchored in the beautiful little harbor of Ayan this evening. This place, possessing the only harbor on the Okhotsk Sea, is nicely situated at the toe of a small horseshoe-shaped indentation in the rugged coast-line. The settlement consists of a few large log storehouses and small dwellings and the inevitable blue-domed church. During the palmy days of the whaling industry it was used by the Americans as a recruiting place, and as a landing place for vast quantities of birch tea, which was sent from there inland to the settlements along the Kolyma River by reindeer during the winter months. Now, since the whalers no longer visit these waters, and the shorter and better route from Ola was discovered, it has lost its importance and the few inhabitants are mostly

employees of the Russian Sealskin Company which owns the magazine and most of the buildings. After spending a couple of hours ashore in collecting flowers which grow abundantly here, climbing the larch- and fir-covered hills, and taking photographs, we left again the same evening.

August 4.—To-night anchored in the open roadstead three miles off Okhotsk. The village, consisting of about a hundred weather-beaten log houses, is situated on a tongue-shaped sand-spit that separates the sea from the lagoon which forms the mouth of the Okhotsk River. The coast, from about four miles above to fifteen miles below the town, is low and extends inland as a wide flat valley through which winds the river. Besides being one of the largest settlements in the marine province of Northeast Siberia, and an important trading centre, Okhotsk is known as the best place on the Okhotsk Sea for salmon. Two species, and perhaps more, are taken here in large numbers, and many of them are smoked and salted and sent to Vladivostok. Fish taken further north in the sea are poor and pale in color. Hundreds of seals were congregated at the mouth of the lagoon catching the fish as they entered the river. Salmon could undoubtedly be taken here in sufficient numbers to supply a cannery, and of very good quality. We remained here five days discharging cargo and left on the 9th and reached Ola the next afternoon. This little collection of Russian and Tungus huts was brought about by the recent discovery of a short and practicable route from here to the headwaters of the Kolyma River. It is located similarly to Okhotsk, on a lagoon formed by the mouth of the Ola River, which has thrown down a large deposit of gravel in the valley between the mountains which end on the sea in high bluffs. Larch and fir trees crowd the river-bottom down quite to its mouth.

August 13.—Resumed voyage to Gichiga, and on the 16th came to anchor in the Gichiginski Gulf and went ashore.

Three miles above the mouth of the Gichiga, on its left bank, is a collection of blockhouses called Kooshka where the commanding officer, or nechalnik, and his assistants live. Here we took up quarters in a cabin which had been occupied

by the government storekeeper and his family, all of whom had died the previous winter from an epidemic of measles and pneumonia, which took off nearly 150 of the inhabitants of the Gichiginski settlement. We were occupied for the next ten days in landing, storing, and dividing our freight.

Mr. Jochelson had expected to find the Koryaks here in their summer camps along the coast, but as they had already abandoned them and returned to their herds and permanent sites he prepared to go to the settled Koryak villages along the head of the Penginski Gulf, and he and the rest of the party left for Parane with a pack-train on September 10.

A large party of Russian workmen, in charge of four American mining engineers, and employed by an English exploration company, arrived from up the river on the 13th, where they had been prospecting for gold. I purchased from them some much-needed provisions, the obtaining of which had been neglected in Vladivostok. On September 24 they sailed on their ship 'Progress,' in company with the 'Mukden,' which had arrived that day, thus breaking the last link that bound me to civilization.

The migration of the birds was already advanced when we arrived, so I immediately set to work to get as many as possible before the long winter closed down, but was unable to accomplish much on account of our cramped quarters and other work until after the departure of Mr. Jochelson.

The coast-line of the Gichiginski Gulf, formed by the mainland and the Taiganose Peninsula, rises boldly from the water to a height of two to three hundred feet, except at its head, where it is low and marshy and entered by the Gichiga and Ovecho Rivers. These two rivers, with their tributaries, drain the triangular valley between the Stanovoi Mountains on the west and a spur which extends south from them and forms the backbone of the Taiganose Peninsula. This valley is a high, rolling tundra, dotted with numerous lakes and pools, and destitute of trees except on some of the dry, elevated places where there is a scant growth of recumbent stone pine, and along the river-bottoms. The mountains to the eastward attain at one point, Babooska, 18 miles from the mouth of the

Gichiga, a height of 1500 to 1800 feet, while those 40 miles distant to the southeastward rise to 3500 feet or more. No timber is found on them. The smaller valleys which the Gichiga and Ovecho have cut out are separated by a high, triangular section of country, which begins at the head of Gichiginski Gulf as a high cliff of recent sandstone, half a mile wide and called Maiak Point, and which separates their mouths. The Gichiga is a rapid, shallow stream about 70 miles long, and flows in a generally north and south direction. At Kooshka, three miles above its mouth, it is 175 yards wide; below this point it rapidly broadens and is filled with bars and flats. The Ovecho is somewhat smaller and flows in a southwesterly direction from the Taiganose Mountains. The river-bottoms near the sea are destitute of trees, but further up they are filled with small willows and alders, and at a distance of 25 or 30 miles contain a thick growth of larch large enough for building material. Still further up there are also birch and poplars.

Formerly the mouth of the Gichiga River was four miles above its present location, where the river is hemmed in by hills on either side, but the gradual rising of the whole valley, shown by the deep deposit of waterworn material all over it, and the deposition of silt at the head of the Gulf, have moved it down to its present position at Maiak Point. At low tide the bottom of the Gichiginski Gulf is exposed for a distance two miles out from Maiak Point as a great mud-flat, extending clear across the head of the Gulf, a distance of eight miles. On this account the vessels anchor about 20 miles out from Maiak, opposite the rocky inlet, Matuga, on the Taiganose side, in 12 fathoms of water. The tides are high and irregular. The difference between high and low water is perhaps nearly 20 feet, and at high tide the water is backed up in the rivers for nearly four miles. It is only at this time that one can row a boat up-stream: above slack water it must be towed.

The town of Gichiga is situated on the east bank of the Gichiga River, 15 miles above its mouth, and is one of the oldest settlements in Siberia, having been located by a party

of Cossacks about the middle of the 18th century. Most of the people now living in this section of Siberia are descendants of these early settlers and the native women, principally Chukchees, whom they took for wives. The population of Gichiga, Christova, Kooshka, and the few isolated fishing stations along the river, numbers about 375. Nearly all of the able-bodied men are enlisted as Cossacks and provided with rations by the government. The affairs of the colony are administered by the local governor, or nechalnik, and his two assistants.

The salmon, which ascend the rivers in immense numbers during July and August, when they are caught and dried, constitute the people's chief supply of food. These, together with the reindeer they obtain from the Tunguses and Koryaks, the wild fowl which they shoot in the summer, and the plain birch tea and sugar which they get from the traders in exchange for work and furs, complete their bill of fare. Owing to the limited resources of the country very few of the inhabitants are able to obtain anything more than a poor existence from it. While many valuable skins and furs are received yearly by the traders at the few scattered settlements in Northeast Siberia, still the territory that they represent is so vast and so thoroughly travelled by the numerous wandering natives and hardy Russians that one finds an amazingly small number of fur-bearing mammals, or indeed of any kind of animal life that will serve for food, in any limited area. Northeastern Asia has undoubtedly for centuries had a vastly larger native population than northeastern America, and the natives there have been in contact with Russians, and acquainted with the use of firearms, for nearly 250 years, so that to-day the animal life of northern Siberia, outside of the timbered portion, is less than that of the barren portion of Alaska.

Snow begins to fall in the valleys the first week in October, and the rivers and lakes freeze over a few days later. The snow falls at intervals from this time on until the middle of May, but probably does not exceed a depth of eighteen inches on the level. However, this is a hard matter to determine, as

strong winds blow almost continually from the northeast and the southwest and pile the snow in huge drifts wherever there is any obstruction. Further inland, away from the seacoast, the winds are not so frequent and the winter weather is pleasanter. There is much overcast and foggy weather, yet the annual precipitation probably does not exceed eighteen or twenty inches, which is quite equally distributed throughout the year, July and August being the dryest months. The temperature at Gichiga ranges from 80° F. to — 40° F. or more, the warmest weather occurring in August and the coldest in January. As soon as winter sets in the people tie up their dogs, repair their sledges, and make everything ready for the long cold season, which is really their most active one, and from this time on until the snow disappears in the latter part of May, they travel almost continually, going in all directions, visiting the Tungus and Koryak lagers and Russian settlements, engaging in trade for themselves or the merchants. The abundance of fish enables every man to keep from ten to sixty dogs. Ten to sixteen constitute a team, although twelve is the usual number. They are hitched in pairs to a long line attached to the sledge, and are trained to drive by word. All of the native Russians are very expert in handling these teams and are the most accomplished travellers on the road that I have ever met in the 'high north.' A good team, with a moderate load, will cover from six to ten miles per hour and is capable of travelling continuously, when necessary, forty-eight hours without food. Satisfactory travelling in the north is limited to the winter months, as the country in the summer, owing to the vast extent of boggy tundra and numerous lakes and rivers, is almost impassable for horses. Mr. Jochelson was seventeen days in September in going with horses from Gichiga to Parane, and later I made the same trip with dogs in thirty hours of continuous travel.

From the time the migratory birds left in the fall until their return there was comparatively little to be accomplished, especially in such a long-settled, thoroughly travelled, and barren country as that section of Siberia, where there are no large wild mammals and few active small ones, and only a

small number of resident birds. Although I secured series of all these winter forms, and of some of them large series, still the work was insufficient to occupy my time, and as I had nothing to read and was unable to carry on any extended conversation with the few people who found their way to my cabin, I passed a very monotonous winter. Many days I was unable to leave the house on account of the severe windstorms which filled the air with snow so that one could not see twenty yards away.

In the latter part of November I took three sledges and visited a large herd of Koryak reindeer which were at that time herded at the base of the mountains fifty miles to the eastward, and selected specimens suitable for a group.

Mr. Jochelson returned to the Kooshka on January 29 from his wandering among the Koryak lagers. I learned from him that there was a number of specimens at Marcova which Mr. Bogoras had sent and which needed my attention. I had originally intended to remain in the vicinity of Gichiga only until March and then go to Marcova and to the mouth of the Anadyr River and await the one steamer which comes there every summer, and return by it to Vladivostok. But on account of my late arrival at Gichiga, the early departure of the vessel from Anadyr the following summer, and consequent shorter time in the field, and other reasons, I decided to alter my plans and put in all my time in the Gichiga territory. However, after consulting Mr. Jochelson, and knowing that there was nothing to be gained by remaining at Kooshka, I decided to go to Marcova, prepare whatever material had accumulated, collect anything else possible, and return to Gichiga in the spring before the snow left and the birds arrived.

I engaged two Cossacks and two sledges with fourteen dogs to each, and on February 21 left Kooshka for Marcova. Marcova is situated on the middle Anadyr River, 500 miles from its mouth and 600 miles from Gichiga. The route over which I was to go was the same as that travelled by the Russo-American Telegraph Company's party of Americans in 1866–67, and so thrillingly described by George Kennan in his

'Tent Life in Siberia.' Since their time I was the first American to make the trip. I left Kooshka at noon February 21, and although the road was heavy from the recent severe snowstorm, we covered the twelve miles to Gichiga in an hour and a half, where we stopped over night. Next day we went as far as Christova, a little settlement of five houses, twenty miles further up the river, and stopped for the night.

February 23.—Fair, calm. Got away at daybreak and followed up the valley of the Chooma River until noon, where we stopped half an hour for tea. Here we left the river and our way for the rest of the day lay across the vast rolling tundra which stretched away in billows of spotless white to the distant mountains whose outlines could be traced on the pale blue sky. At dusk we found a place on the crest of a hill, where we could obtain enough creeping-pine to make a fire, and stopped for the night. After tea and a cup of soup I turned into my 'pavoska,' or covered sledge, and my Cossacks lay down on the snow beside it and slept soundly until morning. Weather too cold for my thermometer, which registers only $-24°$ F.

February 24.—Strong northeast wind blew all forenoon, which filled the air with snow, and later in the day much snow fell, which made travelling slow and laborious. Met two men from Anadyr at noon, and late in the afternoon met six traders. Camped at dusk and made a fire of green stone-pine which we dug from under the snow. The ease with which the Cossacks start a fire, even with a fierce wind blowing, and the celerity with which they prepare tea is wonderful and never ceases to excite my admiration. Twenty minutes after stopping they have a kettle of snow melted, the water boiling, and the tea ready to serve.

February 25.—Strong north wind and overcast. Broke camp at daylight and reached Parane River at noon, where we stopped for tea. Some of the cottonwoods along this river were 40 feet high, and 18 inches in diameter. Just at dusk we reached Quail, a Koryak settlement of ten yomtas, and stopped for the night.

February 26.—Crossed the head of the bay upon which the

settlement was situated and then followed the general direction of the coast-line, cutting off the headlands and approaching the sea in the lower places. Mountains visible in all directions. Crossed long stretches of barren tundra, followed three small rivers for short distances, and finally reached Mickina, where we remained in a Koryak yomta for the night.

February 27.—Reached Shestacova at noon and decided to lie over here until next day, as the next settlement is two to three days' journey. Occupied the day in repairing our freight sledge, buying fish for our dogs, and repacking our sledges. This was formerly a large settlement, but various diseases and epidemics have reduced it to two yomtas. It is situated on a little bay at the mouth of a small river. This and the last place are on the direct line of flight of ducks and geese on their migrations, and they are known as the best places along the head of Okhotsk Sea for shooting them.

February 28.—Turned out at 4.30 and were off at 5 A.M. Our way led up the Shestacova River. Five miles above its mouth its shallow valley suddenly narrows where it cuts through a ledge of basalt, and from that point up it is shut in by mountains on either side. Three miles further we struck into a cañon on the right and began to climb the mountains. Reached the summit, 380 meters elevation, at noon, and after a short stop for tea began the descent. Far below us lay the broad valley of the Ocklan River, whose winding course was marked by the thick growth of trees along its bottom which showed black against the snow. Reached the river late in the afternoon and made camp. Snow so soft we had to break track with snow-shoes.

March 1.—Reached Ooskou Pass, out of the valley (elevation 360 meters), at 3 P.M. The descent was so steep that my sledge capsized and the dogs threatened to run off with us until the driver stopped them and quickly slipped one hind leg of each dog through the harness, this making them three-legged, when we made the rest of the descent in safety. Reached Ooskou at night and camped. Next day, the 2d, reached Pengina, a Russian settlement of fifty-seven people, on the Pengina River. Remained here next day to repair sledges

and rest the dogs for the last stage of our trip. The starosta, or head man of the village, in whose house I stopped, assured me that there was neither flour nor sugar in the settlement, and that all they had to live on was fish, reindeer, and tea. Between here and Marcova there are four small log houses at convenient intervals for the accommodation of travellers when caught in one of the numerous protracted storms which occur.

March 4. — Got away at daybreak and reached the first station on the Chorna River at 3 P.M., when we stopped for tea and then pushed on, the moon being full, until midnight, when we reached the next station. My sledge was ahead and we had arrived, started a fire, unpacked our sledge, and fed our dogs before the other Cossack arrived. His sledge, which was heavily loaded with our outfit and provision, had broken through the ice in crossing a small river and it was with difficulty that he escaped drowning and saved the sledge. Our small supply of sugar and hardtack was soaked, but the canvas in which the main part of the load was lashed somewhat protected the rest of the outfit. After a few cups of boiling tea, some boiled dried salmon, and a kettle of soup, we turned in and slept until 5 A.M., and then resumed our journey. We soon crossed to the headwaters of the Orlofky River and reached the last station at 3 P.M. Encountered a howling blizzard in the Roosky Pass, which separates the Orlofky from the Anadyr valley, and lost our way, but finally got over the pass and reached Marcova at 9 o'clock, where our arrival was heralded by a chorus of the entire dog population. I found Mr. Axelrod and Mr. Bogoras, and the next morning called on the nechalnik, Mr. Sokolnikoff, and the priest who has been here since 1862 and of whom Mr. Kennan speaks in his book. I found people in Gichiga, Pengina, and Marcova who still remembered the members of the telegraph exploration party, and fondly recalled how the 'Americanskis' skated, danced, snowballed, and played ball, and not a few of them still retained a few words of English that they had learned at that time. During the winter of 1899–1900 a Chukchee brought to the nechalnik at Marcova a letter written by Lieutenant Macrae, dated September 25, 1865, which stated that he and

four comrades had been landed at the mouth of the Anadyr River and had been kindly received by the native Chukchees. This letter was written with a pencil on a leaf torn from a notebook and was tied up between two pieces of thin board, after the custom of the country. It was as clean and legible as the day it was written, notwithstanding that it had been carried thirty-five years by the wandering Chukchees before being delivered.

Marcova is a little collection of rough log cabins clustered about the conventional blue-domed Greek Russian church and has, with the outlying fishing stations along the river, a population of about 400. It is situated one half-mile from the Anadyr River, on one of its small tributaries. It requires nine days to go by boat from Marcova to the river's mouth, and fourteen days to return, during the summer. The same journey is made with dogs in the winter in five days. The river is navigable for boats, with a draught of two and a half to three feet, from its mouth to a point fifteen miles below Marcova. Its bottom is thickly lined with a growth of cottonwoods, alders, birches, and willows.

Salmon and herring ascend it during the summer, and several species of *Coregonus* are caught from it in large numbers, especially during the winter.

Mr. Axelrod had prepared most of the few specimens that had been sent, so that after preparing the balance I had but little to do and turned my attention to making a collection of the fish found in the rivers there. In company with Dr. Calleenen we made daily trips to the streams, set nets under the ice, and explored the surrounding country on snow-shoes. Mr. Sokolnikoff gave me a collection of birds that he had made, and I secured much valuable information from him concerning the country between Marcova and the Gulf of Anadyr. The winter weather is very superior to that at Gichiga, and every day I was there it was cold, clear, and calm.

Late on the night of March 21 word was received from Mr. Bogoras, at Baronesskorf Gulf, that he was in poor health and was returning from Kamchatka to the mouth of the Anadyr River, whence he would depart for the north as soon as Mrs.

Bogoras, Mr. Axelrod, and Mr. Sokolnikoff could join him there; consequently I gave orders to my Cossacks to prepare to leave on the 23d. At one o'clock that day, after bidding good-bye to Mrs. Bogoras, Mr. Sokolnikoff, and his secretary, Mr. Dedenko, Dr. Calleenen, Mr. Axelrod, and the host of kind people who had gathered to see me depart, I was lifted into my pavoska by my faithful Cossacks, who released their frantic dogs and we went dashing out of the village in a cloud of snow which glittered like diamond dust in the bright sunlight. Our return journey was uneventful except for being lost in a blizzard one day between Mickina and Quail, when our sledges became separated and again met, each going in opposite directions, after several hours' wandering. The distance from Quail to Christova we accomplished in thirty-six hours of continuous travelling, where we arrived April 1, and on the following day we reached Kooska.

The tide-water broke through the ice on the river April 21, but it was not until May 26 that the ice moved out of the river. The snow began to disappear from the tundra about the middle of May, but was not entirely gone before the first week in June. Where it was heavily drifted, in ravines and along the coast, some remained all summer. In the middle of May I went with sledges to the rocky islets lying along the Taiganose Peninsula, travelling over the ice across the head of the Gichiginski River. Later in the season I again visited these places several times, and also made one trip down the mainland coast as far as Varkhalam Bay.

The first birds arrived about the 20th of April, but no species became common before the end of the first week in May, and the height of the migration was not reached until the last week of May. None of the sea-birds, except the gulls, come up the bay further than Chaibuga Point, some six or seven miles south of my station, and all the other birds stop but a few days at the mouth of the river before continuing their journey inland, where they breed.

The long, vigorous winter suddenly jumps into the short arctic summer, and the grass and flowers spring up before the land is entirely free from snow. The vegetation is abundant,

and the beauty of the flowers is very striking. The grasses, of which there are a number of species, grow very rank in favored places. The summer season of eight weeks, when there are no frosts, together with the moist atmosphere, makes it possible for the people to grow turnips, beets, and carrots in their small, carefully prepared gardens. The mosquitoes, which are the worst feature of life in Northeast Siberia, arrive the first week in July and simply dominate the country for one month. It is impossible to obtain a minute's rest from their attacks during that time.

On the morning of June 16 the first ship of the season arrived, which brought me the first letters and news from the outside world that I had received for ten months. The summer passed quickly, and on August 26 the SS. 'Girin,' from Anadyr, arrived with Mr. Bogoras's collection aboard, he having left the ship at Petropavlovsk, and was detained fifteen days at Gichiga, owing to inclement weather, in discharging her freight. As this was the vessel that was expected to make the next and last trip of the season to Gichiga, and was then more than one month overdue, the captain assured me that it was improbable that there would be another vessel that season, and as the migration was nearly over I decided on September 7 to ship on the 'Girin,' and packed up my collection and closed out my outfit on the 8th and left for the ship that night, arriving there early next morning. Sailed at noon on September 9, stopping at Ola, Okhotsk, and Ayan, and reached Vladivostok on September 28. Found Mr. Bogoras there, and we spent the next two weeks in repacking and arranging our collection for shipment. After several days' delay we finally succeeded in securing a permit from the Governor-General of Eastern Siberia and the constructing engineer to go over the then uncompleted railway, and on October 14 Mr. Bogoras and myself left Vladivostok for Russia. I was the first foreigner that had been favored with a pass over this route, and I was fully repaid for the time I had spent in Vladivostok in obtaining it by the time we gained in crossing Siberia by this route. Our papers were honored at every place along the line, and we were hurried

along on construction trains and special trains, and furnished with government post-horses over the uncompleted section of more than one hundred miles through the Khingan Mountains, so that we reached Irkutsk thirteen days later, and Moscow on November 5; was in St. Petersburg on the 10th, Berlin on the 15th, Paris on the 17th, and sailed from Cherbourg on the 'Kron Prinz Wilhelm' for New York on the 20th, where I arrived November 26, 1902.

During my stay in Siberia I was placed under many obligations to many of the Russian government officials and private citizens, to whom my cordial thanks are hereby extended. I am especially indebted to Governor Chichigoff of the Premorski Province for official letters to the various officers of the posts under his jurisdiction and for an excellent botanical collection from Eastern Siberia; to S. I. Ankoodenoff, Commandant at Gichiga; S. I. Pahderin, Captain of Cossacks at Gichiga; and to N. P. Sokolnikoff, Commandant at Marcova, who gave me much valuable information concerning the Anadyrski country, and also a small collection of birds and mammals. To all the people of the settlements of Ayan, Ola, Okhotsk, Gichiga, and Marcova, and in fact to all the Russians with whom I came in contact, I am deeply indebted for their unlimited hospitality and uniform good-will.

Annotated List of Mammals.

1. **Delphinapterus leucas** (*Pallas*).

White Whale.

Represented by a fœtal specimen. Most of the field notes and the measurements relating to this species were made by Mr. Buxton at Point Barrow, Alaska, in 1898.

"Abundant, probably remaining in the Okhotsk Sea the entire year. During July and August, when the salmon are running, they are especially abundant in the Gichiginski Gulf. At that time, when the tide is high, they come in to the head of the Gulf just off the mouth of the Gichiga and Ovecho Rivers

in hundreds and go out again with the tide. In the summer of 1899 a party of Koryaks who were encamped just below the mouth of the Ovecho River surrounded a school, which had ventured in nearer to the mouth of the river than usual, with their bidarkas, and succeeded in keeping sixteen from returning to the sea until the tide went out and left them stranded on the great mud-flat thus left exposed.

"On October 16, 1900, a fœtus (No. 301 in collection) was brought to me which had been taken from a female killed off the mouth of the Gichiga River a few days previously.

"A Finn now living at Gichiga was formerly employed there by the American Trading Company in catching 'white fish' for their oil. The Russian name of the white whale is *Bi-loo-hah*, and not *Bi-loo-gah*, as the American whalers call them, which is the Russian name for a large species of sturgeon.

"The following unpublished notes were taken at Point Barrow, Alaska, in 1898. — On the morning of May 3, Mr. Chas. Brower of the Cape Smythe Whaling and Trading Company sent word to Mr. McIlhenny that a native had just arrived from one of his floe whaling camps with word that they had found a school of white fish in a 'hole' and had already killed 70. Mr. McIlhenny and his Japanese cook, together with two Eskimos and dog team, set out immediately for the scene. That night the cook returned with a note to me asking for a dog team and natives. Next morning I started with four Eskimos and a sledge. After a rapid journey of five hours over the sea ice we reached the 'hole.' On the way we met more than twenty different gangs of natives with sledges loaded with 'white fish' skins and meat.

"On May 2 the wind blew lightly from the northeast until 3 P.M., when it hauled to the southwest and drove the ice-pack in and closed up the series of holes between the pack-ice and the land-floe, or 'ice-foot,' attached to the shore, except one which the whales had found.

"At 10 o'clock that night some of the Eskimo from the whaling camp who had gone out after seals discovered the fish imprisoned in this hole. The hole when first discovered was about 150 yards long and 50 yards wide, but when I

reached there the young ice had formed around the edges until it was only 60 by 20 yards. The water was about 30 fathoms deep. At the time of my arrival, there were 150 carcasses, some with the skin, meat, head, flukes, and flippers removed and others untouched, lying on the ice, while nearly one half that number were tied up to the edge of the ice in the water. Over 100 more were still alive in the water. These rose to 'blow' every twelve to eighteen minutes and then made from ten to fifteen blows, sometimes making two in swimming the length of the hole, and then, turning back, repeating the operation several times before again descending. The inspiration and expiration required not more than one or two seconds and sounded like an exaggeration of the noise produced by a person rounding the lips and blowing. Over one hundred Eskimos were there, and new parties were continually arriving and others departing as they got their sledges filled. All of the new arrivals immediately tried their skill at shooting, although there were many more killed than would supply their wants.

"The whales in rising came up with the forward part of the body elevated, pushed the top of their head out of the water, and 'blowed,' and then, with tail depressed, back elevated, and head pointed downward, disappeared again, seldom showing the fluke. This gave the appearance of a circular disc revolving in the water with only about one fourth of its diameter exposed. The head was seldom raised enough to show any part of it below the eye. Some rose and swam for some distance parallel with the surface of the water, but most of them described sharp curves. Although all did not rise at the same time, yet the majority rose together, and smaller numbers came up between the main risings, so that there was no period of more than six minutes when some were not visible. When the main rising occurred the hole was almost filled and they were so thick that occasionally one would be pushed high in the air with its tail up and body two thirds out of the water and held that way for a second before disappearing again. At no time were there less than five natives shooting, and sometimes as many as twenty. Probably not

more than one in five of those killed were secured, as many mortally wounded went off under the ice, and all those not instantly killed immediately sank. A bullet placed just back of the base of the skull, dislocating or breaking the spinal column, gave the best results, and nearly all killed in that way floated. Nearly every one of those still alive had at least one bullet-hole in it and I saw one that had eight.

"At the time I visited them the greater part were the dark colored or younger individuals, although those first on the scene said that the dark and light colored ones were about equally represented. Every one in shooting would pick a large white one as long as they lasted. The colors represented all the shades of slate and hair brown, gradually fading into pure white. The majority of the adult females were pregnant, the fœtuses measuring from 1450 to 1700 mm. in length. The fœtuses were uniform dark slate color with lighter rings around the eyes. Three calves, about eight feet in length, following their mothers, were darker than the fœtal ones and mottled with chocolate brown. These had not yet cut their teeth. From this size up the color gradually became lighter, some being light slate, others smoke gray and hair brown, until on those from 11 feet 9 inches to 12 feet the color entirely disappeared, leaving them milk or ivory white, except a dark purplish brown stripe about an inch wide on the posterior edge of the fluke, on the dorsal and ventral edge of the 'small' or just anterior to the fluke, on the free edge of flippers, and a sooty ring around the eyes. In still older ones the sooty ring around the eyes was wanting, and the dark markings on fluke, small, and flippers was more subdued. Some of the large white ones had a distinct chlorine green tinge. The fœtuses are lighter than the calves and darker than the medium-sized ones; after birth they assume a darker color and become mottled with chocolate; then they soon begin to fade until the color has entirely disappeared, except as previously stated, leaving them pure glossy ivory or milk-white. When the larger dark colored individuals are examined closely they present a uniform hair brown color punctated with small darker ovoid spots. A transverse sec-

tion through the skin of one of these shows the dermis pure white and the base of the epidermis black, gradually fading towards the surface. Small black pigment lines run from this black base to the surface, giving it the spotted appearance. On the white ones the epidermis is entirely white with no black at the base nor pigment lines running through it.

"In an adult white specimen the epidermis was 9, dermis 4, and blubber 53 mm. thick, and in a large hair-brown specimen the epidermis was 9, dermis 7.4, and blubber 43 mm. thick. The blubber is clean and vinaceous cinnamon in color. The eyeball of an adult male was 30.5 and the iris 16.8 mm. in diameter; iris hazel brown. In no specimen did the bulge of the forehead extend beyond the lips.

"The teeth, which are irregular and peglike in form, are loosely set with wide spaces between them in the rubber-like gum. The normal formula is $\frac{10-10}{9-9}$, but this is seldom found, owing to loss or suppression. In one large male it was $\frac{10-10}{8-9}$; those above all inclined forward, and the first four on each side below inclined forward and the others backward. The two posterior teeth were curved and horn-shaped, and lay forward flat on the gums. The first four on either side below were worn down until they resembled short posts; the second four above had half of the crown worn away, leaving them tusk-shaped. In younger specimens the teeth are more regular.

"The internal ear cavity of nearly every specimen examined contained small, filiform worms, about 19 mm. long and .25 mm. in diameter. In some the cavity, which is quite large, was almost entirely filled with them.

"I again visited the place on May 7 and counted 164 carcasses on the ice, and Mr. Hobson, whose whaling camp found the school, told me that his natives had thrown 70 more back into the hole. About 20 were still alive in it, but these were killed later, and 20 dead ones were in the water frozen in by the ice. Nearly 300 of the school were thus accounted for, and estimating that only one in three was secured after being killed, although I think that one in five wounded would be nearer the truth, it is seen that it originally contained not less than 900 individuals, not one of which escaped."—N. G. B.

MEASUREMENTS OF *Delphinapterus leucas*, TAKEN[1] AT POINT BARROW, ALASKA, MAY 2–7, 1898.

No.	Sex.	Length.	Girth behind Flippers.	Length of Right Flipper.	Width of Right Flipper.	Length of Gape.	Girth of Head at Spout-hole.	Spout-hole to Front of Mouth.	Width of Spout-hole.	Width of Flukes.	Length of Flukes.	Girth of Small.	Diameter of Eye.	Base of Flippers to end of Nose.	End of Fluke to Mammæ.	Distance between Mammæ.
1	♂	4473	2402	508	485	280	1296	585	76	991	508	502	25	940	—	—
2	♀	3965	2211	494	280	241	1207	457	76	813	432	483	25	782	1067	915
3	♀	4194	2465	457	369	267	1245	546	76	940	483	496	25	864	118	928
4	♂	4956	2656	559	330	305	1423	610	76	1080	572	534	25	953	—	—
5	♂	4982	2796	534	457	343	1500	661	76	1093	610	559	31	966	—	—
6	♂	4778	2618	547	483	305	1398	610	76	1042	521	521	25	953	—	—
7	♂	4905	2821	559	457	318	1525	623	79	1118	585	572	25	966	—	—
8	♀	3914	2135	330	312	229	2169	445	76	826	432	457	25	637	991	—
9	♀	4092	2370	429	330	260	1220	546	76	330	445	483	25	839	1106	—
10[2]	♂	4804	2643	584	508	343	—	572	76	330	—	635	—	—	—	—
11[2]	♀	4041	2313	369	318	241	—	470	76	292	457	470	—	—	—	—

[1] By Mr. Buxton, in feet and inches, and here reduced to millimeters.—J. A. A.

[2] To angle of flukes; in all other cases, to end of flukes.

Nos. 2, 3, 8 and 9 were pregnant females; their fœtuses measured, respectively, 1601, 1716, 1550, 1589 mm.

Mr. Buxton's notes contain references to several other species of Cetacea observed by him, but no specimens were collected. These include the Killer (probably *Orca rectipinna* Cope), of which one was seen at Ayan, August 3, 1900, and two others in the bay at Okhotsk, September 18, 1901. Porpoises were seen off the coast of Korea in May, 1900, and at Okhotsk in September, 1901. Also Humpbacks and Finbacks off the coast of Saghalin Island in September, 1901, where many are taken by the Kaiserling Company "for their oil and flesh, which is sold principally to the Japanese for food."

Respecting the 'Right' Whale, probably *Balæna sieboldii* Gray, he says: "Saw two Right Whales between Ayan and Okhotsk on August 4, 1900"; and adds:

"The hunting of this species was formerly prosecuted with great energy by the Americans in Okhotsk Sea and adjacent waters, but is now almost totally abandoned, only one or two filibustering schooners visiting these waters each year. One American schooner visited Penginski and Gichiginski Gulfs in the spring of 1900 and secured several whales. The same one returned in April and May, 1901, but got none. I saw some 'three-foot' bone in a Koryak yomta at Shestacova on Penginski Gulf. An occasional one is seen off the mouth of Gichiga River by the people living there and the coast Koryaks now sometimes catch one along the Taiganose Peninsula. Slabs of bone sawed from the whale's lower jawbone are used by the Russians and natives to shoe their sledges with late in the spring."

2. **Rangifer tarandus** (*Linn.*).

REINDEER.

Reindeer are represented by specimens of both wild and domesticated animals, from several quite widely separated localities, including two races of the domesticated Reindeer. These specimens were collected partly by Mr. Buxton and partly by Mr. Bogoras, as follows: A series of 5 specimens, skins and skulls, collected for mounting by Mr. Buxton,

Nov. 6, 1900, from a large herd about 50 miles east of Gichiga, on the Taiganose Peninsula, consisting of a large 7-year-old male, a younger adult male, a yearling male, a 4-year-old female, and a 2-year-old female; also two fawns three days old, taken April 30, and 2 fawns four weeks old, taken June 14; also two flat skins, to show the variations of color, and a skin of a female taken by Mr. Axelrod at Marcova, Nov. 15, 1900. These all belong to the Lamut race of Reindeer.

Mr. Buxton also obtained the skins, without skulls or measurements, of two wild Reindeer at Marcova, a female and a young male, killed and brought in by hunters.

Mr. Bogoras's series includes 4 skins and skulls of wild Reindeer collected at Mariinski Post, mouth of the Anadyr, at different dates, and several additional skulls; also 6 young fawns of different ages and two skins and skulls of females of the Chukchee domesticated race, and one skin and skull of a female of the Lamut domesticated race.

Although this material seems considerable it is insufficient, both in quantity and character, to enable one to make satisfactory comparisons between the wild and domesticated animals, or between the two commonly recognized domestic races, the Lamut and Chukchee. Also material is lacking in sufficient quantity to give much new information in respect to the supposed differences between the Reindeer of Siberia and of Scandinavia. Most of the adult males were killed when the antlers were in the velvet, and the pelage had not acquired its full winter development. The color of these skins is much like that of our Eastern Woodland Caribou, at least in general effect; the antlers, however, are longer and slenderer, and partake more of the Greenland type.

Mr. Buxton's measurements of the Taiganose Peninsula specimens are as follows:

No. 18179, a 7-year-old male, is unfortunately without measurements. No. 18180, an adult male: "Length, 1750 mm.; tail, 125; hind foot, 510; girth, 1190; height, 970. A fine, large individual."

No. 18178, a 4-year-old female: "Length, 1630 mm.; tail, 125; hind foot, 480; height at shoulders, 940; girth behind fore legs, 1030; girth of neck, 530; head of humerus to head of femur, 860. A perfect

specimen of a 4-year-old female of average color and size and with perfect, average-sized antlers, selected from a herd of more than 2000 which varied in color from pure white to a dark seal brown."

No. 18182, young female, "A fine average individual. Length, 1405 mm.; tail, 120; hind foot, 450; height, 785; girth, 910."

No. 18181, yearling male. "A very fine specimen, of average size and color, in good pelage, and with as good antlers as it was possible to find in a herd of more than 2000. Length, 1375 mm.; tail, 119; hind foot, 440; height at shoulders, 760; girth, 860."

A detailed report on this material is necessarily deferred till a later occasion, when a more general study of both the Old World and American forms of *Rangifer* can be undertaken.

The following notes by Mr. Buxton supply much interesting information:

"Wild Reindeer. Russian name, *Dēeka Ō-láin*, meaning wild reindeer. Undomesticated reindeer are still quite common in the country about Marcova. Every few weeks during the winter travellers in that territory report seeing small herds of them and a few are killed and brought to Marcova every winter. There are some in the Gichiga territory. The specimens in the collection were taken in February, 1901, near Marcova. The skin of the wild reindeer is much thinner than that of the domesticated form and the hair is much lighter in texture. They are smaller also than the domesticated ones.

"Domesticated Reindeer. Russian name, *Ō-láin*. Representatives of nearly all the different tribes of native people inhabiting that vast section of northern Eurasia lying between the Arctic Ocean on the west and Bering Sea on the east have from the remotest times maintained herds of reindeer. As these animals are so constituted by nature than they can be utilized for food, clothing and transportation, they form a very important factor in the existence of these high north people. The Chukchees who inhabit the extreme northeastern corner of Siberia, between the Arctic Ocean and Bering Sea, possess the largest herds of any of the Siberian natives, some of them containing as many as 20,000. The Koryaks living to the south of those along Bering Sea and around the head of Okhotsk Sea also have large herds, and the Tunguses,

further inland and along the shore of Okhotsk Sea, also possess considerable numbers of them, The Lamuts, along the lower Kolyma, are also reindeer people.

"The Lamut are the largest of all the domesticated deer in Northeastern Siberia, and the Tungus are larger than those of the Chukchees or the Koryaks. This difference in size is probably accounted for by the fact that the Chukchees and Koryaks inhabit a treeless country, while the Tunguses and Lamuts live in the timbered section further inland. I had the opportunity of observing but one large herd, which was kept on the Taiganose Peninsula, and contained four or five thousand. In the latter part of November I visited it in order to obtain some for food and specimens. At that time they were in full, unworn pelage. The older ones had shed the velvet from their horns, but the young ones still retained it. In color they ranged from pure white to dark seal brown, although the general color of the adults is a brownish gray. The younger ones are darker. The antlers are generally smaller and more terete than those of the North American Barren Ground Caribou, while the animal itself is larger. During the latter part of January the oldest animals begin to shed their antlers, but all do not complete the process before the latter part of May. The young are dropped from the middle of April to the first of June. In May they begin to change pelage and complete it in August and the early part of September. The antlers are full grown from August to October.

"This herd was owned by one Koryak, the head man among the Koryaks in that region, who kept twelve men and their families to look after the deer. The camp, consisting of three very large deerskin tents, is moved quite often in order to afford them good feed. One or two men are in constant attendance day and night, summer and winter. Many of the reindeer are broken to ride and drive; and nearly two hundred sledges are used in moving the camp. The animals are very tame and are easily caught with the long sealskin lariats, which the men handle very dexterously.

"Reindeer in Siberia generally give birth to young when

they are two years old, and it is exceptional for them to have young when one year old; but those that have been imported to Alaska foal at one year old, and it is exceptional for them to go until they are two. Also in Alaska a large percent has twins.

"They are inferior to dogs for travelling, being able to make only about one half the distance of a dog team in a day, and they are unable to endure the continuous work of dogs." —N. G. B.

3. **Paralces alces** (*Linn.*).

Elk.

The Elk has apparently disappeared from the region bordering the Okhotsk Sea, but still exists further inland. No specimens are included in the collection.

"Russian name, *Lōs*. The Russians at Gichiga say that Elk were formerly found at Parane on the head of Penginski Gulf, and that a few are still taken near Yamsk. Mr. Jochelson says that they are abundant in the valley of the Kolyma River."—N. G. B.

4. **Moschus moschiferus** *Linn.*

Musk Deer.

The collection contains a single specimen of Musk Deer, a young male, collected by Mr. Jochelson in the Verkhoyansk Mountains, near the junction of the Yana and Dulgulach Rivers, Yakutsk, Siberia. The general color above is blackish brown, strongly varied with yellowish gray; ears blackish, fringed internally with white; throat and breast dusky strongly varied with white. The collector's measurements are: Head and body, 780 mm.; tail, 30; hind leg, 468; girth, 490.

It is hardly probable that the north Siberian form, represented by the present specimen, can be subspecifically the same as true *moschiferus* of the Himalayas, but lack of material prevents a critical consideration of the subject. Pallas's name *Moschus sibiricus* is apparently available for the northern form, should it prove separable.

5. **Ovis nivicola** *Eschscholtz.*

KAMCHATKA BIGHORN.

Represented by 3 skins with skulls, and one skin with skeleton, collected by Mr. Buxton on Taiganose Peninsula, April 4, 1901, and by one skin and skull and four pelts purchased by Mr. Bogoras at Baronesskorf Gulf.

Mr. Buxton's measurements of three specimens in the flesh are as follows:

No. 18211, ♂. Total length, 1350 mm.; tail, 102; hind foot, 395; height, 840; head of humerus to head of femur, 760; girth, 1000; girth of neck, 510.

No. 18213, ♀. Total length, 1380 mm.; tail, 90; hind foot, 373.

No. 18210, ♂. juv. (quite young). Total length, 1070; tail, 86; hind foot, 325; height, 665; head of humerus to head of femur, 665; girth, 690; girth of neck, 330.

The skull of No. 18211, adult male, measures: Basal length, 223 mm.; least interorbital breadth, 111; greatest orbital breadth, 156; mastoid breadth, 95; length of nasals, 68; breadth of nasals at middle, 38.5; palatal length, 131; length of upper toothrow, 72; length of horns along outer edge, following the curvature, 588; spread at tips, 470; circumference at base, 255.

The skull of No. 18212, an older and much larger male from Baronesskorf Gulf, measures: Basal length, 252 mm.; least interorbital breadth, 125; greatest orbital breadth, 168; mastoid breadth, 95; length of nasals, 83; breadth of nasals at middle, 43; palatal length, 137; length of upper toothrow, 65; length of horns along outer edge, following the curvature, 730; spread at tips, 453; circumference at base, 295.

The skull of the adult female, No. 18213, measures: Basal length, 240 mm.; least interorbital breadth, 104; greatest orbital breadth, 144; mastoid breadth, 80; length of nasals, 78; breadth of nasals at middle, 26; palatal length, 129; length of upper toothrow, 70; length of horns along curvature, 167; spread at tips, 116.

As the description and figure of this sheep given in 'Wild Oxen, Sheep, and Goats of All Lands' (pp. 221–226, pl. xviiiA) are quite misleading as to the color of the animal the following description, based on a good series of specimens, is here presented. Eschscholtz's figure is also incorrect as to color and does not agree well with the same author's good description.

Male, winter pelage.—General color yellowish gray brown, lighter on the flanks and over the middle region of the body, darker on the shoulders, top of neck, and hinder part of back. Ears short, heavily clothed, brown like the surrounding parts except the apical fourth which is whitish. Forehead and face yellowish white, with a broad zone of brown across the nose, but end and sides of nose whitish; chin, throat, breast, and most of ventral surface dark brown; inguinal region, inside of thighs, and buttocks clear white, the caudal disk divided by a dark band from the back continuous with the dark brown tail, which is darker than the general tone of the back. Fore and hind limbs dark ruddy brown, with a narrow band of dull white on the posterior surface. Horns yellowish brown, or brownish wax-yellow.

The four pelts, in full winter pelage, vary little in coloration except that some are a little darker or a little lighter than others. The four April skins, complete, with leg bones and feet, have the coat somewhat worn and are a little lighter from bleaching. Otherwise the two adult males are as above described; an adult female is lighter colored throughout than the males, and a yearling male lamb is still lighter than the female, the general coloration being light brownish with a yellowish cast, the front of the legs darker. The tips of the hairs are whitish with the under pelage brownish, showing slightly through the surface.

In none of the 7 adult skins, all in winter pelage, is there any indication of a white winter coat, which Dr. Lydekker appears (*l. c.*) to have unjustifiably assumed, in view of what other observers have stated, may characterize the Kamchatka Bighorn. In all of the four skins that have the head skin complete, the nose and face are white, but the brown area across the upper part of the nose varies in extent, being very broad in one, much narrower in another, and practically absent in a third.

In color, size, slenderness, and curvature, the horns closely resemble those of the *Ovis dalli-stonei* group, but the general coloration of the animal is much different from either, closely resembling that of typical *O. canadensis*.

It is surprising, however, in view of the material now available for comparison, that the Kamchatka Bighorn should have ever been considered specifically identical with the

American forms, although these are, of course, its nearest affines.

"Russian name, *Dee-ke Bar-an*, meaning wild sheep. Mountain Sheep probably occur all over Northeastern Siberia wherever the mountains are rugged enough to attract them, although I have only a few reliable records of their presence at widely separated places in that vast territory. They are found in the Stanovoi Mountains, at Ayan, Okhotsk, Ola, Yamsk, Mickina or Niakinsk, and on as far north at least as the Arctic Circle, and perhaps further, although the range becomes much less rugged towards the north. They are also found along the Kolyma River to the westward of that range. A few are taken in the mountains in the Anadyr Territory about Marcova. They are common on the Taiganose Peninsula, and are said to be abundant all over Kamchatka from Petropavlovsk northward. Kamchatka, from the nature of its mountains and vegetation, offers the most suitable place for them. The wandering reindeer Koryaks inhabiting the Taiganose Peninsula kill a few every winter. Three of those in the collection are from that locality, while the fourth is from Baronesskorf Gulf." — N. G. B.

6. **Sciuropterus russicus** (*Tiedemann*).

SIBERIAN FLYING SQUIRREL.

Mus volans LINNÆUS, Syst. Nat. ed. 10, I, 1758, 64 (in part; based primarily on *Sciurus volans* Seba, exclusively American).

Sciurus volans LINNÆUS, Syst. Nat. ed. 12, I, 1766, 88 (in part).

"*Pteromys russicus* TIEDEMANN, Zool. I, 1808, 451."

Pteromys sibiricus DESMAREST, Mamm. II, 1822, 342 (= *Sciurus volans* Pallas, non Linnæus).

This species is represented by four hunters' skins, without skulls or feet, obtained by Mr. Buxton at Marcova, obviously winter skins. Three of them have the upper parts nearly uniform pale whitish gray, while the fourth has a barely perceptible tinge of pale buff; the lower parts are white with a very faint buffy tinge, and a slight mixture of black-tipped hairs overtopping the general pelage. The tail is grayish

white above, strongly varied with long black-tipped hairs, and with a tinge of buffy brown; below similar but more strongly washed with buffy brown. Eyelids black; a broad superciliary stripe and cheeks white; an indistinct blackish lateral line of short hair along the sides of the neck; fore feet (present in only one specimen) gray blotched with blackish; hind feet above gray like the back, and pale buffy white below.

Fourteen specimens in alcohol, collected by Mr. W. Jochelson at Verkhne Kolimsk, on the Kolyma River, in December, 1901, are similar in coloration, except that some of the specimens are more tinged with buffy, especially on the tail and feet. These specimens afford the following measurements:

MEASUREMENTS OF *Sciuropterus russicus.*

Mus. No.	Locality.	Date.	Sex.	Total Length.	Head and Body.	Tail Vertebræ.	Hind Foot.
19522	Verkhne Kolimsk, Kolyma River	Dec. 1901	♂	247	150	97	38
19526	" " " "	"	♂	270	170	100	34
19528	" " " "	"	♂	275	175	100	35
19529	" " " "	"	♂	273	170	103	35
19531	" " " "	"	♂	259	174	85	36
19532	" " " "	"	♂	280	174	106	36
19521	" " " "	"	♀	271	170	101	37
19523	" " " "	"	♀	268	168	100	36
19524	" " " "	"	♀	281	175	106	37
19525	" " " "	"	♀	253	150	103	35
19527	" " " "	"	♀	274	172	102	33
19530	" " " "	"	♀	279	173	106	33
19533	" " " "	"	♀	283	170	113	35
19534	" " " "	"	♀	285	173	112	37
	Average, 6 males and 8 females	—	—	272	169	104	35.5

An adult male skull has a total length of 42 mm. and a zygomatic breadth of 25 mm.

Without other material it is impossible to compare the present series with the Flying Squirrel of northern Europe, commonly known as *Sciuropterus volans* (Linn.). As, however, the *Mus volans* Linn. 1758 (and earlier in Syst. Nat. and Faun. Suecica) was based primarily on the *Sciurus volans* of Seba and other references to the American animal, the name

volans has of late been properly restricted by American writers to the Virginia form of the group. The first name available for the northern Europeo-Asiatic animal is apparently *Pteromys russicus* of Tiedemann. (I have not Tiedemann's work at hand, but find this name repeatedly cited for the north European animal.)

"Russian local name, *Lee-tyá-gah.* Flying Squirrels are common in the wooded section inland from Ayan, Okhotsk, and Ola, and all over the wooded section westward from Gichiga and in the Kolyma River district. A very few are still found near Yamsk and along the immediate headwaters of the Gichiga River. No. 472 and 486 (pelts) were taken at Yeropole, 100 miles northeast of Marcova, where there is pine timber. Mr. Jochelson says that they are abundant along the Kolyma River as far north as timber line." — N. G. B.

7. **Sciurus vulgaris calotus** (*Hodgson*).

SIBERIAN SQUIRREL.

Mustela ? calotus HODGSON, Calcutta Journ. Nat. Hist. 1841, 221–223, pl. ix. Himalaya and Thibet. Type from Thibet, *apud* Gray, Ann. and Mag. Nat. Hist. (3) XX, Oct. 1867, 272.

Sciurus calotus GRAY, Ann. and Mag. Nat. Hist. (3) XX, Oct. 1867, 272. "Hab. North China, Thibet (Mr. Hodgson's type), Siberia, B. M."

Sciurus vulgaris calotus BARRETT-HAMILTON, P. Z. S. 1899, 6. "Hab. Eastern Siberia, the exact limits uncertain; . . ."

? *Sciurus vulgaris argenteus* KERR, Ann. King. 1792, 256. River Obi. (*Cf.* Barrett-Hamilton, *l. c.*, p. 6.)

Ten specimens, collected by Mr. Buxton in February, 1901, "on the Yeropole River, 100 miles northeast from Marcova," are in full winter pelage, with black ear-tufts, black tails, and blackish brown feet. These specimens agree quite well with Mr. Hodgson's description (*l. c.*), from imperfect skins, of his "*Mustela ? calotus*," which, he says, is "clear slaty blue freckled vaguely with hoary; the amply tufted ears, the spreading tail, and the limbs blackish"; "and the middle of the belly and the neck in the same line, together with the insides of the limbs close to the belly are pure white."

These specimens are exceedingly uniform in color, the upper parts being dark gray, with a barely perceptible wash of brownish over the median area from the middle of the back posteriorly. The soles of the feet are clothed with very long, thick, closely matted woolly fur, of a grayish brown color.

Measurements.—Ten specimens (6 males and 4 females) measure as follows: Total length, 395 (372–420) mm.: tail vertebræ, 171.4 (154–192); hind foot, 63.6 (57–69). An average adult skull has a total length of 52 and a zygomatic breadth of 31 mm.

In addition to the above described series of ten specimens from Marcova, Mr. Buxton obtained at Gichiga and at Marcova, a series of 20 hunters' skins to illustrate the color variation to which this species is subject. The exact locality of these specimens is unknown, but they must have come from the general region tributary in trade relations to these points. These are complete skins except that they generally lack the feet. There are also 6 hunters' skins obtained by Mr. Bogoras at Marcova, which lack tail and feet. These six agree in coloration with the above-described Marcova skins collected and made up as specimens by Mr. Buxton.

The Buxton series of 20 hunters' skins is deserving of special mention on account of the wide color variations they present. Eleven of them are like the 16 dark gray specimens already enumerated and call for no special remark. Of the other 9, three are albinistic, — pure white below as in normal specimens, with the rest of the pelage dull light creamy brown, with the tail and ear-tufts somewhat darker than the general coloration. The remaining six have the general coloration of the body (the median ventral surface excepted) light ashy gray, many shades lighter than the dark gray series; three of them have the tail and ear-tufts bright red. They thus agree with the winter pelage of *Sciurus vulgaris varius* (Kerr), of Scandinavia and eastward to northern and central European Russia, as defined by Barrett-Hamilton (*l. c.*, p. 6). The other three have dusky brown ear-tufts with a faint reddish tone, and dusky reddish brown tails, with more or less reddish on the crown and at the base of the ears,

and a reddish brown shade over the lower back. They are thus more or less intermediate between the three last described and the ordinary dark gray phase, as regards the ear-tufts and tail, but more reddish on the lower back and head. It might be inferred that the six light gray specimens with more or less reddish ear-tufts and tails came from some point far to the westward, and thus represent the north European form, were it not that Mr. Bogoras assures me that all of these phases of coloration occur in the region immediately about Marcova. The albinistic phase and the specimens with red ear-tufts and red tails, he informs me, are very rare, and are looked upon by the hunters as 'curiosities.'

"Russian name, *Bél-kah.* Although an enormous number of pelts of this handsome little mammal are annually brought to the settlements along the Okhotsk Sea and to Marcova very few are now found in the vicinity of any of these places. Inland, in that vast section of Northeastern Siberia which is covered with coniferous trees, they are still abundant and their skins are the chief source of revenue to the natives inhabiting that territory. A few are still found near the western shore of Okhotsk Sea, along the upper Gichiga and Pengina Rivers and along the tributaries of the Anadyr system. From two to five thousand are yearly brought to Marcova; from seventy-five to one hundred thousand to Gichiga; from one hundred to one hundred and twenty-five thousand to Okhotsk, and about five thousand to Ayan and Ola. Formerly many more than this were brought out at Ayan, the receipts having dropped off four fifths in the past twenty years. They are killed principally by the Tunguses during the winter with old-fashioned small-bore flint-lock rifles. The skins are removed, turned inside out, dried and tied up in bundles of ten, in which shape they are brought to the coast during the summer — July — and traded to the merchants or at the government magazines for powder, lead, iron, tea, and rye flour. The price varies from eighteen to twenty kopechs each, although the government allows them but fifteen. Nearly all of them are used in Russia for lining fur garments." — N. G. B.

8. **Eutamias asiaticus** (Gmelin).

Pallas Ground Squirrel.

Sciurus striatus Schreber, A. Das asiatische, Säug. IV, 1785, 790.

Sciurus striatus, α. asiaticus Gmelin, Syst. Nat. I, 1788, 150. Based on *Sciurus striatus* Pallas, Nov. Spec. Quad. Glir. Ord. 1778, pp. 378–384, ex Siberia.

Type of present description, No. 18474, ♂ ad., Gichiga, Northeast Siberia, August 12, 1900; N. G. Buxton, Jesup North Pacific Expedition.

Post-breeding Pelage.— Front half of dorsal surface, from nape posteriorily, and sides of shoulders, light gray faintly tinged with yellowish; rest of dorsal surface, including top of head, rump and thighs, yellowish brown; five black dorsal stripes, the median one extending from crown to base of tail, the inner pair from sides of nape to rump, the outer pair from shoulder to hip, all equally distinct and about equal in width; the four light dorsal stripes are whitish gray anteriorly and yellowish rufous posteriorly, the outer pair less strongly yellowish than the inner pair; supraocular stripe, from nose to posterior border of eye, pale buffy white, from eye to ear rusty brown; subocular stripe, from front border of eye to posterior base of ear, pale buffy white, confluent with the small white postauricular patch; below this a broad maxillary streak, rusty brown mixed with black-tipped hairs; fore and hind feet pale dingy buffy gray; whole ventral surface with a barely appreciable tinge of buff; ears like the top of the head, with narrow whitish tip and edging; tail with the hairs broadly tipped with white, giving a general whitish gray effect, the hairs individually being pale rufous at base, forming, when seen from below, a broad central area of pale yellowish rufous, about one third the total width of the tail; this area is bordered with a band of black, and a broad outer edging of white.

Measurements.— Type, total length, 259 mm.; tail vertebræ, 113; hind foot, 37. Four adult males and eight adult females measure as follows: Males, total length, 258 (250–265); tail vertebræ, 118 (112–129); hind foot, 38.5 (37–40). Females, total length, 261 (253–280); tail vertebræ, 116 (108–120); hind foot, 37.5 (35–39).

Skull.— Type, total length, 37 mm.; zygomatic breadth, 21; length of nasals, 13; posterior breadth of nasals, 3.4.

This species is represented by 12 specimens collected at Gichiga, 11 of which were taken July 6–10, 1901, and one September 27, 1900; and one from Ola, about sixty miles south of Gichiga, taken September 12, 1900; also one from Marcova, without date. A single specimen from Saghalin

Island, collected by Dr. Berthold Laufer, in August, 1898, is not appreciably different from the Gichiga series. This series of 15 specimens is quite uniform in coloration, varying only in the color of the lower back, which is a little deeper fulvous in some of the specimens than in the type. The series differs strikingly, through very much paler coloration, from a series of 10 specimens in the U. S. National Museum from the upper Amoor River, representing Bonhote's *Tamias orientalis* (Ann. and Mag. Nat. Hist. (7), IV, Nov. 1899, p. 385). It has only a remote relationship, as would be expected, with *Eutamias senescens* Miller (Proc. Acad. Nat. Sci. Phila. 1898, p. 349), from Pekin, China, the type of which is before me.

With proper material for comparison, the Siberian *Eutamias* proves to be not closely related to the most northern form of the genus in North America, namely, *E. quadrivittatus borealis*, of which I have for comparison a series of nearly 100 specimens collected at various points in northern British Columbia. The American form is fully one half less in size (as regards bulk of body), and very much darker and otherwise strikingly different in coloration.

Sciurus striatus Pallas (Nov. Spec. Quad. Glir. Ord. 1778, pp. 378–384), which later became the basis of Gmelin's *Sciurus striatus, α. asiaticus* (Syst. Nat. I, 1788, p. 150), included all the then known striped Ground Squirrels of Europe, Asia, and America. His description was based on a Siberian specimen, but, as usual, he failed to state the locality whence his material came. He speaks of the Siberian form as frequenting all of the wooded parts of Siberia, from the Kama and Dvina Rivers eastward to Kamchatka. His description indicates an animal with five black dorsal stripes, and with the general coloration above pale lutescent. As he fails to mention the conspicuous reddish color of the head and lower back which especially distinguishes the Amoor River form (*Tamias orientalis* Bonhote), and as his description satisfactorily characterizes the animal of the Gichiga region, there seems to be no alternative but to restrict the name *asiaticus* to the Gichiga animal.

Schreber, with his usual astuteness, properly discriminated the Asiatic animal as different from the American, as "A. Das asiatische," but failed to give it a technical name, which was first supplied later by Gmelin, as above cited.

"Russian name, *Bŭr-ŭn-dóok.* Abundant at Ayan, Okhotsk, and Ola, common at Gichiga and Pengina, and present at Marcova. At Gichiga they are confined to the upper stretches of the rivers where the larch (*Larus sibirica*) grows, and to the patches of recumbent stone-pine (*Cembra pumila*) along the seacoast. I spent the second week in July, just at the height of the mosquito season, encamped at the junction of the Gichiga and Chooma rivers. The country between these streams is a park-like expanse of dry, level country, covered with an open growth of Siberian larch, and with tangled masses of willows close to the river-banks. Under the trees is a thick growth of grass and flowers. I am certain that the chipmunks were very common, although I secured only ten, nine males and one female, during five days of almost continuous tramping through these woods, and heard but two more. Eight of the ten were feeding on the green cones in the tops of the larch trees, where they would remain motionless and allow me to approach to the foot of the trees. The other two were startled from the grass and immediately ran up trees. Most of the females taken had been nursing young. They retire to their winter quarters the last week in October and do not come out again until the first week of the following June. At Ayan I saw several of them during the first week of August feeding on the green cones of *Larus ayensis*, which there crowd the little valley quite down to the beach. Mr. Sokolnikoff says that they occur along the Yeropole and Main rivers, tributaries of the Anadyr, northeast of Marcova. Several of the chipmunks killed at Christova had their cheek pouches filled with the green seeds of the larch and larvæ of a large ant abundant there in the woods." — N. G. B.

9. **Citellus**[1] **buxtoni,** sp. nov.

East Siberian Spermophile.

Type, No. 18403, ♂ ad., Gichiga, west coast of Okhotsk Sea, Siberia, August 19, 1901; N. G. Buxton, Jesup North Pacific Expedition.

[1] *Cf.* Allen, this Bulletin, XVI, 1902, p. 375.

Post-breeding pelage. Type.— Front and top of head deep rufous, varied minutely on the crown with black-tipped hairs; rest of the dorsal area yellowish brown, thickly covered with small squarish spots of white, narrowly edged posteriorly with black; sides and ventral surface ochraceous, wholly concealing the plumbeous underfur; back and sides with many long, stiff, wholly black hairs; front and sides of the nose, chin, and upper throat deep buff; upper surface of both fore and hind feet rusty buff; upper surface of tail blackish, especially towards the tip, conspicuously fringed with deep fulvous, the hairs individually being grayish fulvous, then narrowly ringed with black, then with a broader ring of deep fulvous, followed by a broad band of black and a broad fulvous tip; lower surface of tail deep orange rufous, with a subapical black band, reaching nearly to the base of the hairs, and edged and tipped with fulvous.

In breeding dress (left-over winter coat) the pelage is thin and worn, and the general coloration is much paler, through fading and wear, so that in many specimens the sides of the neck and shoulders are gray, almost without trace of fulvous; the sides are pale fulvous gray, the deep orange or ochraceous tint of the ventral surface is much paler, and the fulvous fringe of the tail has bleached to yellowish white.

Young of the year, one eighth to one half or two thirds grown, resemble in a general way the faded breeding adults, but the pelage is softer and more woolly, and the markings and tints are less developed; the crown patch is paler and mixed more or less with gray, the scapular region is pale, and the dorsal region grayish brown varied with black, with the spotting poorly defined.

Ten adult males and ten adult females measure as follows: *Males*, total length, 356.8 (340–380) mm.; tail vertebræ, 90.9 (80–104); hind foot 59.2 (57–62); *Females*, total length, 358.7 (345–374); tail vertebræ, 90.3 (80–101); hind foot, 58.5 (56–60).

This species is represented by 48 skins and skulls, 3 specimens in alcohol, and 10 additional skulls, taken at Gichiga by Mr. Buxton at various dates from May 21 to October 5, and 7 specimens obtained at Indian Point (Chaplin Point of most maps), by Mr. Bogoras, in June, including two pure white albinos, purchased of the natives.

In post-breeding pelage the coloration varies considerably in different specimens. The description given above of the type indicates about the average condition, from which the coloration varies chiefly in the depth of the ochraceous color of the sides and ventral surface, which ranges in different specimens from orange to pale ochraceous, with a corresponding variation in the amount of fulvous suffusing the dorsal

area and the border of the tail. The amount of fading shown by May, June, and early July specimens, which still retain the left-over winter pelage, also varies, some specimens having the shoulders and sides of the neck whitish gray, with scarcely a trace of fulvous, while in others a distinctly fulvous tone infuses the gray.

Citellus buxtoni finds its nearest relative in *Citellus barrowensis* (Merriam) from Point Barrow, Alaska, from which, however, it differs in smaller size and relatively as well as absolutely shorter tail, the average measurements of 7 adults from Point Barrow, collected on the McIlhenny Expedition, being as follows: Total length, 421 (382–470); tail vertebræ, 145 (130–178); hind foot, 60.4 (57–65). The general style of coloration is the same, but the Point Barrow animal has the dorsal area a darker brown, and the fulvous suffusion of the sides and underparts is very much paler. The difference in size is especially striking on comparison of the skulls, an average adult skull of *barrowensis* giving a total length of 61 mm. as against 58 in *buxtoni*, while the dentition in the former is much heavier, the length of the upper toothrow being 15 mm. as against 12 in *buxtoni*. Among other cranial differences may be noted the form of the posterior narial opening, which is not only narrower in *buxtoni*, but the pterygoid processes curve more strongly inward.

The other American forms of the *parryi* [1] group differ, as

[1] In adopting, some years since, the name *empetra* (*Mus empetra* Pallas) for the group of Parry Spermophiles (see N. Am. Rodentia, 1877, pp. 842–844, and Bull. Am. Mus. Nat. Hist., X, 1898, p. 454) I was influenced largely by Schreber's plate of *Arctomys empetra* (Säuget., pl. ccx), which Schreber says (*op. cit.*, IV, 1785, p. 744) was transmitted to him by Pallas. This plate clearly does not represent any known species of *Arctomys*, while it does fairly well represent the large rufous-headed spermophile of northern North America, later known as *Spermophilus parryi*. Pallas's brief description, paraphrased by Schreber, is unsatisfactory, corresponding better perhaps with a half-grown specimen of the northern form of the common woodchuck (*Arctomys monax* auct.) than with the Parry Spermophile, the top of the head and feet being described as brownish black instead of rufous; but the ventral surface is said to be "rufo-ferruginea," and the size is given as between that of a marmot and the small spotted spermophile of Europe (*Mus citellus* Linn.).

Pallas cites (Nov. Spec. Quad. Glir. Ord., 1778, p. 75) both Pennant's and Forster's 'Quebec Marmot,' the latter being the Parry Marmot and the former, in all probability, a young woodchuck, so that Pallas's *Mus empetra* was in any case composite. Sabine, in 1822 (Trans. Linn. Soc. London, XIII, 1822, p. 584), used Pallas's name *empetra* for the northern form of the woodchuck, describing under this name specimens received from the Hudson Bay Company. This may be taken as definitely fixing the name *empetra* upon the northern woodchuck, leaving the name *parryi* Richardson as available for the spermophile (*Citellus parryi* ex Richardson), with Lyon Inlet, Melville Peninsula, as its type locality. Thus, in order to clear up a vexatious case of nomenclature (see Osgood, N. Am. Fauna, No. 22, Oct. 1902, p. 47), it seems best to ignore the alleged figure of Pallas's *Mus empetra*, since it was not published by Pallas, and clearly disagrees with his previously published description.

would be expected, still more widely from *buxtoni* than does its nearest geographical neighbor, *barrowensis*.

C. buxtoni has only a remote relationship to *C. eversmannii* (Brandt) from the Altai Mountains, the latter being very much smaller, with relatively longer tail, and very different coloration, wholly lacking the rufous head-patch so characteristic of *C. buxtoni* and the whole *parryi* group.

"Russian local name, *Ōv-ráhs-ka*. Abundant in suitable places at the mouth of the Anadyr River, Marcova, Pengina, Gichiga, Ola, Okhotsk, and Ayan. Mr. Jochelson says that it is also abundant in the Kolyma country, where they are sometimes eaten by the natives when other food is scarce. At Gichiga larger or smaller colonies of them are scattered all along the river banks and along the high bluffs which overlook the sea. On the right bank of the Gichiga River, about five miles above its mouth, is a wide sandy bottom, a few feet above the river, which in the summer is covered with a thick growth of grass and flowers. This bottom for nearly a mile along the river and two hundred yards inland is covered with spermophiles' burrows, and the colony contains three or four hundred individuals. During summer their runways radiate from these burrows in all directions and cross one another in the tall grass. At this time one can see them sitting erect at their holes and running through the grass, and hear them utter their sharp *shick-shick* of alarm. They begin to come out of their winter quarters as soon as the snow begins to leave, about the second week in May, and return during the last week in September. The young are born about the time they emerge from hibernation. Their food consists of green grass and plants and their seeds, which they store, at least in limited quantities." — N. G. B.

10. **Citellus stejnegeri**, sp. nov.

Kamchatka Spermophile.

Spermophilus brunniceps Kittlitz, Denkwürdigkeiten einr Reise, etc., II, 1858, 337. Nomen nudum. Southern Kamchatka.

Spermophilus parryi Brandt (nec Richardson), Bull. phys. math. Cl. Acad. Sci. St. Pétersb., II, 1844, 373, part; only the reference to the Kittlitz specimen, as above.

Type, No. 63226, U. S. Nat. Mus., ♂? juv., near Petropaulski, southeastern Kamchatka; Dr. L. Stejneger.

Allied to *C. buxtoni* from Gichiga, but very different in coloration, and rather larger, with heavier dentition.

General coloration above gray shaded with blackish, and varied with small squarish white spots; sides gray with a faint tinge of pale fulvous; ventral surface dingy gray; sides of shoulders, fore arms and feet, and the whole pectoral region strong fulvous, palest on the breast and brightest on the fore arm; thighs and hind feet fulvous gray; chin, throat, and sides of the nose pale buffy white; top of the nose as far as the eyes chestnut rufous; top of head from middle of eyes posteriorly blackish tinged with dark rufous; tail above basally mixed blackish and gray, the apical third of the vertebral portion and the tip black, the tips of the hairs pure white, forming a white fringe; tail beneath fulvous gray centrally for the basal two thirds, the central area bordered with black, the apical third all black fringed with white.

Measurements.— There are no measurements, taken from the fresh specimens, available. Approximate measurements from the skin are as follows: Total length, 306 mm.; tail vertebræ, 75; tail to end of hairs, 110; hind foot, 55. Skull, total length, 53 mm.; zygomatic breadth, 31; nasals, 20; upper toothrow, 13.

A second specimen (U. S. Nat. Mus. No. 14136), also from near Petropaulski, and collected by Dr. Stejneger, for whom the species is named, — a flat skin, lacking feet, tail, and skull, — is exactly similar to the one already described, so far as the body is concerned. The type specimen is nearly full grown, as shown by the skull, in which the permanent premolars are just coming into place, their crowns being visible beneath the milk teeth, three of the four milk premolars being still retained.

Compared with *C. buxtoni* of exactly corresponding age, *C. stejnegeri* is characterized by the absence of any fulvous suffusion of the back, and of the strong ochraceous tint of the sides, limbs, and ventral surface. The tail has a very much larger area of black, and is fringed with white instead of fulvous. As regards the skull, the dentition is heavier, and the palatal floor much less curved downward posteriorly, it being in *C. stejnegeri* nearly flat throughout and in *C. buxtoni* strongly arched for the posterior third.

Dr. Stejneger has kindly called my attention to the following passage in Kittlitz's 'Denkwürdigkeiten einr Reise,' etc.

(Vol. II, 1858, p. 337) as possibly furnishing a name for this species. Kittlitz says: "Hier [in the mountains near Ganal] ward zwischen Alpenpflanzen plötzlich eine weibliche Jewraschka gefangen, ein kleines Murmelthier, das dem *Arctomys citillus* nahe steht. Die Art unterscheidet sich von ähnlichen bei Pallas beschriebenen haupträchlich durch die geringere Zahl der Mammellen, deren nur acht sind. Das Exemplar ward in Petersburg unter dem Namen *Spermophilus brunniceps*, Brandt, aufgestellt und von mir im Jahr 1835 beschrieben und abgebildet." I am unable, however, to find that Kittlitz ever published a description or figure of the animal, or that the name *Spermophilus brunniceps* has ever appeared elsewhere. Brandt appears not to have published it, as in 1844 (Bull. Acad. Sci. St. Pétersb., phys.-math. Cl., Vol. II, 1844, p. 373) he identifies this same specimen with *Spermophilus parryi*. The name *Spermophilus brunniceps* as used by Kittlitz is practically a *nomen nudum*, since the only feature mentioned, the number of mammæ, cannot be considered as sufficiently distinctive.

11. **Arctomys,** sp.?

SIBERIAN MARMOT.

The genus *Arctomys* is not represented in the collection. Mr. Buxton refers to a species of this genus in his notes as follows:

"*Arctomys* sp.? Marmot. Russian local name, *Tār-bah-gàn.* The people living at Gichiga say that a species of marmot is found at Baronesskorf Gulf where they are abundant. Mr. W. H. Shockley, an American mining engineer, who was in charge of an English expedition which prospected the coast of Siberia for gold from East Cape to Petropavlovsk in the summer of 1900, said that they were abundant at Olutorski Gulf where they lived in the rocks along the coast. In the summer of 1901 I saw a Yakutsk native from the Kolyma River district with a cap made from their skins, and he explained to me that it was a mark of wealth to possess such a cap, although at Baronesskorf Gulf the skins are worth but sixty kopecks each."— N. G. B.

12. **Evotomys (Craseomys) latastei,** nom. nov.

KAMCHATKA RED-BACKED MOUSE.

Arvicola rufocanus varieté *kamtschaticus* LATASTE, Ann. Mus. Civ. di Stor. Nat. di Genova, XX., 1884, 284 (in text). The range here given as "dans le Kamtschatka, sur les bords de l'Armour, auprès du lac Baïkal, sur l'Altaï, et généralement, dans tout le nord de la Sibérie." Not *Arvicola kamtschaticus* Polyakoff, 1881.

E. latastei differs from *E. rufocanus* in its much smaller size, less angular teeth, rounder bullæ, less fulvous underparts, and darker gray sides.

A series of 18 specimens (including two in alcohol) collected at Gichiga, is provisionally referred to this species, the type region of which is northern Kamchatka. In the absence of typical representatives of *E. kamtschaticus* any other course seems inexpedient.

The Gichiga series was taken as follows: Jan. 12, 1; May 12, 1; June 25, 1; Aug. 27, 1; Sept. 11–24, 14. The January specimen is in very long, soft pelage, clear grayish white below, the sides rather light clear gray, and the back yellowish rufous, with numerous long black-tipped hairs. The May specimen is in shorter, less full pelage, with the color much as in the January specimen, except that the rufous of the back is more dilute, through the less developed fur, but of the same tint. The adult September specimens are darker, the sides being of a darker gray, the ventral surface deep pure gray with a whitish wash, and the back dark rufous or chestnut. Young specimens about two thirds grown, partly in the soft woolly pelage of the young, have the sides and lower surface practically as in September adults, but the back in one specimen (the youngest) is only slightly suffused with rufous, restricted to the median region; in others, somewhat older, the rufous is stronger and suffuses a broader area.

The external measurements of 10 adults are as follows: Total length, 128 (120–140) mm.; tail, 29 (24–33); hind foot, 19 (18–20). Six adult skulls measure as follows: Total length, 23.6 (22.5–25) mm.; basal length, 20.5 (19–22); zygomatic breadth, 13 (12–13.8); nasals, 6.2 (5.7–6.5).

[The name *kamtschaticus* (*Arvicola rufocanus* var. *kamtschaticus* Lataste, 1884) cannot be used in this connection, owing to the previous *Arvicola kamtschaticus* of Polyakoff (1881). It may therefore be called *Evotomys latastei*, after the author who first recognized the form.

13. Evotomys wosnessenskii (*Polyakoff*).

WOSNESSENSKI RED-BACKED MOUSE.

Arvicola wosnessenskii POLYAKOFF, Zapiski Imp. Acad. Sci. St. Pétersb. XXXIX., No. 2, 1881, 56.

Evotomys wosnessenskii MILLER, Proc. Acad. Nat. Sci. Phila. 1898, 361. Description, synonymy, etc.; Bering Island and Petropaulski, Kam.

This species is represented by 83 specimens (including six in alcohol), all taken at Gichiga, as follows: April 10–13, 2; June 29, 1 (juv.); July 26–29, 4 (2 juv.); Sept. 24 and 30, 2; Oct. 2–27, 49; Nov. 1–11, 15; Dec. 15 and 20, 2. All but twelve are adult and are exceedingly uniform in coloration. The two April specimens and the two December specimens have the red of the back a little lighter or paler than the September-October series, with the pelage longer and fuller, and the tail more heavily clothed. The young specimens (half to three fourths grown) are duller colored, with the soft woolly pelage of immaturity, and the red of the back not fully developed. Two nursing young, in very short close pelage, have the dorsal area orange rufous, the sides orange, and the ventral surface yellow in one specimen and white in the other, in which latter also the sides are somewhat paler. This coloration cannot be considered as due to the effect of formalin or alcohol, as the adults preserved with them, when removed from the preserving fluid and dried, do not differ from the skins.

In adult autumn specimens the back is rich chestnut rufous varied with black-tipped hairs; sides yellowish buff; ventral surface clear dull white, the plumbeous underfur imparting a grayish cast. About one specimen in ten has the ventral surface faintly washed with buff, strongest posteriorly.

This series does not differ appreciably in coloration or cranial characters from specimens in the U. S. National

Museum from Bering Island and Petropaulski, Kamchatka. The latter measure slightly larger in total length (collector's measurements from the fresh specimens), with shorter tail and slightly smaller hind foot, but the discrepancy may be due to different methods of measuring.

Measurements.— Ten adult males and ten adult females measure as follows: *Males:* Total length, 128.8 (121–137) mm.; tail vertebræ, 29.6 (26–34); hind foot, 18.8 (17–22). *Females:* Total length, 130.4 (120–136); tail vertebræ, 30.1 (26–32); hind foot, 18.3 (18–19). Eight adult Bering Island and Petropaulski specimens (collected and measured by Dr. L. Stejneger) measure: Total length, 137 (134–143); tail vertebræ, 27.5 (23–35); hind foot, 17 (16–17.5).

The hairiness of the tail varies greatly with the season and individually, in some specimens the tail being thinly haired and lightly pencilled; in others, taken at nearly the same time, the tail is very thickly haired and has a heavy pencil.

Mr. Buxton apparently did not recognize that there were two species of Red-backed Mice in his collection. His field notes, covering both *E. wosnessenskii* and *E. latastei*, are as follows:

"Russian name, *Mysh.* This is undoubtedly the most abundant mammal found in the territory I visited, although the series in the collection is the result of one year's continuous trapping for them. At Gichiga they are found everywhere on the tundra except in the more barren places where nothing but moss and lichens grow. In places where there is a growth of grass and flowers or low shrubs, and along streams and in timbered places, they are most abundant. They are also common about houses. When I took up quarters in my cabin many were living there, which I soon caught; and at that time there were a great many open containers of hardbread, peas, beans, and cracked buckwheat. Later in the year I found a number of collections of these things about the house which they had made. In one old boot was more than one quart of hardtack crumbs, buckwheat, rice, and peas. At Kooshka there are three government storehouses standing in a row. The two end ones are 100 yards apart. In one end house are kept rice, flour, and buckwheat, and in the other

metal goods and manufactured wares. In this latter house the storekeeper often finds large accumulations of rice and buckwheat which have been brought by the mice from the other magazine more than three hundred feet away. In the houses they are active during the entire year, and I think young are born in every month, but on the tundra they are inactive during the winter; I caught the most there during August and September, and very few during the summer. In the moist places where the fine grass grows, grass cuttings and droppings are plentiful, but baited traps set there caught very few of them. I caught several in my cabin with their cheeks filled with rice." — N. G. B.

14. **Evotomys jochelsoni,** sp. nov.

Kolyma Red-backed Mouse.

Type, No. 19538, ♀ ad., Verkhne Kolimsk, Kolyma River, February, 1902; W. Jochelson, Jesup North Pacific Expedition.

Based on two adult specimens preserved in spirits, collected by Mr. Jochelson as above. Dorsal area, from front of crown to tail, bright rufous, with a slight intermixture of black-tipped hairs, the pelage being dark plumbeous for the basal two thirds, then banded with ochraceous and broadly tipped with rufous; sides ochraceous, including the front and sides of the head; ventral surface bright buff; tail above dusky, sides and below bright buff, heavily clothed; ears tipped with rusty internally.

Measurements.— Type: Total length, 107 mm.; head and body, 85; tail vertebræ, 22; hind foot, 17. The other specimen has a defective tail (probably due to injury in life), measuring as follows: Head and body, 80; tail, 13; hind foot, 17. *Skull*, total length, 22; mastoid breadth, 11; length of nasals, 6.3.

This species differs from *Evotomys wosnessenskii* and *E. rutilus* through the much lighter red of the dorsal area, the strongly ochraceous sides, and the buffy underparts. It is also smaller. It differs so radically in coloration from the *Craseomys* group (*E. rufocanus* and *E. latastei*) that no comparison with these forms is necessary.

15. **Microtus kamtschaticus** (*Polyakoff*).[1]

KAMCHATKA VOLE.

Arvicola kamtschaticus POLYAKOFF, Zapiski Imp. Acad. Sci. St. Pétersb. XXXIX., No. 2, 1881, 43, fig. 4, dentition. Kamchatka.

Microtus kamtschaticus MILLER, Proc. Biol. Soc. Wash. XIII., 1899, 11 (in text).

Represented by 33 specimens, of which 12 were collected at Marcova, March 7–20, and 21 at Gichiga, the latter as follows: Jan. 12, 1; July 28, 1; Aug. 1–3 and 29–31, 5; Sept. 1 and 24, 2; Oct. 1–4, 12. One of the specimens is very old, 9 are fully adult, and 8 are young adults, the rest being immature, of various ages, from nurslings to specimens one half to two thirds grown. The January specimen is only about half grown, the March series contains two less than half grown, some of the July specimens are quite young, and the October series includes nursing young, half grown, and adults; hence, apparently, young are reared at all seasons of the year.

The March series of adults are in full soft winter pelage, with heavily furred tails, and the dorsal pelage about 20 mm. long. They differ greatly in respect to pelage from the July, September, and October adults, in which the coat is quite short and the tail thinly haired. They are also darker and browner. There is, however, much individual variation in color, and in the length of the tail, in specimens taken practically at the same date, there being a tendency to a yellowish brown phase and to a reddish brown phase, with many intermediates. The March adults are strong buffy brown above varied strongly with black-tipped hairs, the general color ranging in tone from yellowish brown to slightly rufescent brown; lower parts clear grayish white, the plumbeous underfur tinging the otherwise nearly clear white superficial tint. The tail is sharply bicolor, the lower surface being white and the upper surface blackish mixed slightly with gray-tipped hairs; feet dull grayish white.

In September specimens the dorsal pelage is only about

[1] Poliakoff appears to attribute the name *kamtschatica* to Pallas, citing a "*Mus œconomicus*, var. *kamtschatica* Pallas, Novæ spec. Quadrp. e Gliri Ord. p. 233." But Pallas did not use the name in a nomenclatorial sense, but in a descriptive or geographical sense. He says: "Varietas Kamtschatica muris œconomi, cujus exuvias habeo," etc. The name should therefore date from Polyakoff, 1881.

12–15 mm. long, and of a deeper, more reddish brown, varied with black, giving a much darker general effect. The ventral surface is whitish gray with a very slight wash of buff. The color of the young in the woolly immature coat is in general similar to that of fall adults, but of a duller tint above and more plumbeous below.

Three additional specimens, taken at Indian Point, Siberia, by Mr. Bogoras, seem not in any way distinguishable from the Gichiga and Marcova specimens collected by Mr. Buxton.

The following table gives the external measurements of 18 specimens, taken by Mr. Buxton from the fresh specimens, arranged in the order of size, with which are included the two principal measurements of the skull, when the skull is not too much broken to be available. The specimens range in age from young adults to very old, some of the last six being still partly in immature pelage.

MEASUREMENTS OF *Microtus kamtschaticus*.

Mus. No.	Locality.	Date.	Sex.	Total Length.	Tail Vertebræ.	Hind Foot.	Total Length of Skull.	Zygomatic Breadth.
18580	Marcova	March 20, 1901		190	48	20	28.5	—
18594	Gichiga	Sept. 1, 1900	♀	185	50	21	—	—
18610	"	Aug. 16, 1901	♀	180	46	22	28	15
18581	Marcova	March 20, 1901	♂	175	45	23	29	—
18588	Gichiga	Aug. 3, 1901	♂	175	44	19	27	15.4
18586	"	" 2, "	♀	172	46	20	25	16
18578	"	Oct. 3, 1900	♂	170	45	22	—	15
18600	"	" 4, "	♂	166	50	21	—	—
18585	"	July 28, 1901	♂	166	41	21	27	15
16001	"	Oct. 4, 1900	♂	160	44	21	—	—
16587	"	Aug. 1, 1901	♀	156	41	19	—	14
16576	"	Sept. 2, 1900	♂	146	36	21	25.3	14
16577	"	Oct. 3, "	♀	144	36	22	25.5	14
16582	Marcova	March 20, 1901	♂	144	33	21	25.6	14.6
16583	"	" " "	♂	138	36	21	—	—
16579	"	" 7, "	♂	137	29	22	26.5	14.5
16593	Gichiga	Aug. 31, 1900	♂	136	35	22	25	14
16584	Marcova	March 20, 1901	♂	134	32	21	24	13

The above-described specimens of *Microtus* from Gichiga and Marcova have been compared with a series from Kamchatka identified by Mr. Gerrit S. Miller as *M. kamtschaticus*, and do not appear to either Mr. Miller or myself to differ from them.

"Russian local name, *Mysh.* This species is not as common as the Red-backed Mouse and is more partial to the houses. The majority of the specimens in the collection were taken about cabins. The others were taken in the same place as the Red-backed Mice. It is also active about the houses during the winter, but continuous trapping on the tundra during the winter revealed none there. It is possible that the grass cuttings and droppings in grassy places are done by this species. They also accumulate large stores of provision, and their habits and distribution, so far as I observed, are practically the same as those of the Red-backed."—N. G. B.

16. **Dicrostonyx torquatus** (*Pallas*).

PIED LEMMING.

A single specimen of *Dicrostonyx* was collected by Mr. Buxton near Gichiga, June 23, 1901. It closely resembles in coloration June specimens of *D. nelsoni* Merriam from Point Barrow, Alaska. The skull is broken, only the lower jaw and rostral portion being present. In the absence of specimens of *D. torquatus* for comparison, it is provisionally referred to that species. Mr. Buxton refers to this specimen in his field notes which here follow, and to which he has added some very interesting and hitherto unpublished notes on the two species of Lemming observed by him at Point Barrow, Alaska.

"No. 840, male, 6-23-'01. This specimen was brought to me by a Tungus who caught it near their summer encampment at Chevitka, 10 miles down the mainland coast from Kooshka. He said that this was the only one that he had ever seen there, but far inland they were common. I showed it to the captain of the Cossacks, S. I. Pahderin, a man 54 years of age who had lived here all his life, and he said that during April and May, 1900, there were hundreds of them on the tundra about Gichiga. The dogs hunted them day and night at that time and required no other food. The people here had never seen one previous to that time and were greatly puzzled to know from where they had come and whither they had gone. They have no distinct name for it

and simply call it 'mysh' or mouse. The commanding officer, Ankoodeenoff, also said that he caught two of them in his house in the spring of 1900. I saw the track of one on the snow in February, 1901. Their tracks are very easily distinguished from those of the mice, or even from those of *Lemmus*, as the long, stiff hairs protruding beyond the toes of *Dicrostonyx* drag on the snow and make a very characteristic track.

"Concerning specimens of *Lemmus trimucronatus* and *Dicrostonyx hudsonius alascensis* Stone [= *D. nelsoni* Merriam, of 10 days' earlier date], taken by the McIlhenny Expedition to Point Barrow, Alaska, 1897–98: As far as I observed, the habits of these two species of lemmings are the same. During the summer they are seldom seen, and then only while running from one burrow to another, as at that time their runways are under the moss which covers the tundra everywhere. In winter, when the moss freezes, they run tunnels in all directions on the tundra just under the snow and up to the surface of the snow. After a high wind many may be seen running about on top of the snow, apparently lost or unable to regain their burrows. This gives rise to the superstition, which is current among the coast Eskimos from the mouth of the Mackenzie River to the Yukon, that the white ones are sent whirling down with the snow from the sky by Puk-ai-mu-n̂a as his messengers, and that when they have accomplished their mission they disappear. They call them Kĭl-ĭ-mai-u-tah, and are adverse to killing them. The Norwegians also have a similar superstition concerning this species in winter dress.

"In summer their nests, runways, and droppings are encountered everywhere on the tundra, especially on the higher, black hummocks and along low banks which border the lagoons. In winter and spring they are often found far out on the sea ice, sometimes two or three miles from shore. The statements made by other writers concerning their comparative scarcity and abundance in different years is verified by the natives and whites here. The young, at least of *Lemmus hudsonius alascensis*, are born every month in the year. Six is the usual number brought forth at a time. Their food consists of grass and weed seeds and bulbous roots.

"Mr. Brower, who had been at Point Barrow 10 years as a trader, had never seen a *Dicrostonyx* until we showed him one, although he had observed many *Lemmus* and one large migration in 1888. Our series of the former contained 48 specimens, all that we could obtain, while that of the latter contained 606, and we could have taken many times that number had we cared to do so.

"During May when the snow was melting, leaving only patches scattered over the tundra, one could see hundreds of them in a day's walk on the tundra. At that time the moss is still frozen so they cannot burrow in it. On one day at this time our Japanese cook killed 105 in one day. On June 21, 1898, I counted over 100 in a fox burrow. On June 7, 1898, found five *Lemmus* and two *Dicrostonyx* in a nest of the Snowy Owl, both of the latter still white enough to be very conspicuous against the black tundra.

"Considering that these two lemmings have about the same habits and the same environment it would be interesting to know why the one that changes to white during the winter and has horny pads on his fore feet, and is apparently better fitted in every way to elude his enemies and obtain food, is so much rarer than the other form which is not so well equipped." — N. G. B.

17. **Lemmus obensis chrysogaster,** subsp. nov.

GOLDEN LEMMING.

Myodes schisticolor MIDDENDORFF (not of Liljeborg), Sibirische Reise, Säugethiere, 1853, 108. "Westküste des Ochotskischen Meeres (Ajan)."

Type, No. 18762, juv., Gichiga, west coast of Okhotsk Sea, July, 1901; N. G. Buxton, Jesup North Pacific Expedition.

Two specimens, a skin and skull, and a specimen in spirits, taken by Mr. Buxton at Gichiga, July 26, 1901.

The spirit specimen (type), dried out to show its coloration, is yellowish brown above varied with black, more grayish brown and less yellowish on the head and neck, the fulvous tint gradually increasing in brightness and amount from the shoulders posteriorly, becoming strong yellowish rufous on the lower back and rump; sides and ventral surface orange ochraceous, paler on the throat and at the base of the tail; chin and sides of mouth soiled buffy white; top of nose pale

dusky brown, passing posteriorly into the dull yellowish gray-brown of the upper surface of the head; feet dusky grayish brown; claws dusky horn color; ears very small, orbicular, wholly concealed in the fur; tail very short, the upper surface dusky, the lower surface and a long pencil grayish white. Incisors pale yellow.

Measurements.— Total length, 97 mm.; head and body, 78; tail vertebræ, 10; tail to end of pencil, 20; ear from crown, 4; hind foot without claws, 14; with claws, 17; claws of fore foot, 6.

Skull.— Total length, 25; basal length, 22; length of nasals, 6; length of palate, 13.5; zygomatic breadth, 16.5; mastoid breadth, 13; interorbital constriction, 4; upper toothrow, 7.

The skin belongs to a young adult, which differs from the spirit specimen in being much darker and less ochraceous; dorsal surface dusky brown, almost blackish over the whole middle region of the back, with a very short tipping of pale rusty on some of the hairs, imparting a faint rusty general tint; sides ochraceous; ventral surface rusty buff, palest on the throat.

This species differs from *Lemmus obensis* (Pallas), as described in great detail by Middendorff (Sibir. Reise, Säuget., pp. 99–108, pll. VIII–X) from a large series collected on the Taimyr River, in the much richer, brighter orange color of the sides and upper parts, and the orange ochraceous instead of whitish ventral surface. It agrees more closely in coloration with Point Barrow specimens of *Lemmus alascensis* Merriam, but the under parts are brighter, and it is very much smaller. The two skulls, both quite young, show no distinctive cranial differences.

This is doubtless the *Myodes schisticolor* Middendorff, but not the *M. schisticolor* of Liljeborg. Middendorff's specimen was a skin and skull brought by Wosnessenski from Ajan (or Ayan), on the west coast of Okhotsk Sea, about 600 miles south of Gichiga.

18. **Ochotona kolymensis,** sp. nov.

KOLYMA PIKA.

Type, No. 19535, ♂ ad., Verkhne Kolimsk, Kolyma River, Yakutsk, Siberia, December, 1901; Waldemar Jochelson, Jesup North Pacific Expedition.

Based on two specimens in alcohol, collected as above. Pelage very soft and thick. Above pale yellowish brown, strongly varied with black over the median area, less black and more strongly yellowish on

the sides; the hairs individually plumbeous for their basal three fourths, then abruptly pale fulvous and tipped with black; head less fulvous and more grayish; ventral surface soiled yellowish white, strongest over the pectoral region, the plumbeous underfur well concealed by the light tipping of the hairs; feet soiled grayish white with a faint buffy tinge above, dull brownish gray beneath; ears with a narrow pale rim, the long hairs within pale buffy gray, the short hairs clothing the outer surface dusky plumbeous; nose and upper lip dusky brownish, sides of nose lighter, buffy gray.

Measurements. — Head, 43 mm.; body, 110; total length (approximate), 153; hind foot, 24; ear from crown, 12. (Correct measurement of the length in a straight line is difficult owing to the rigidity of the specimens and their bent positions.)

Skull.— Total length, 37 mm.; basal length, 29; zygomatic breadth, 14; mastoid breadth, 19; length of palatal floor, 3; length of nasals, 10.8; upper toothrow, 7.

This species appears to differ strongly from *O. littoralis* (Peters), from the eastern end of the Chukche Peninsula, in general coloration, and especially in the absence of all trace of ferrugineous on the sides of the neck and throat, and it is also larger. It differs from *O. hyperboreus* (Pallas), also from the Chukche Peninsula, in its somewhat larger size and in having the upper parts pale yellowish brown instead of ferrugineous. It appears to have no very close relationship with *O. alpinus* (Pallas), from the Altai Mountains, differing from it in coloration and smaller size.

19. **Lepus gichiganus,** sp. nov.

GICHIGA HARE.

Type, No. 18286, ♂ ad., Gichiga, west coast of Okhotsk Sea, Jan. 11, 1901; N. G. Buxton, Jesup North Pacific Expedition.

Winter pelage, pure white, generally to the extreme base of the underfur; in some specimens the extreme base is pale gray. Ears narrowly tipped with black.

Summer pelage, head and back gray-brown tinged with yellowish brown; sides, lower back, rump, and thighs clear dark gray; ears tipped with dark yellowish brown.

Measurements.— Total length (type), 584 mm.; tail vertebræ, 75; hind foot, 173; ear from notch (in dry skin), 78. *Skull*, total length, 93; basal length (Hensel), 74; postpalatal length, 55; greatest zygomatic breadth, 49; mastoid breadth, 33; postorbital constriction, 19; length of nasals, 38; breadth of nasals at base, 21; length of upper

toothrow (on alveolar line), 17; length of lower jaw, 67; height of lower jaw, 46.

Young female, about one third grown.— General color above grayish brown with a faint fulvous tinge; the abundant woolly underfur is pale plumbeous at base, with the apical third pale rusty fulvous; the longer overhair is dusky, broadly ringed subapically with white, and ending in a fine blackish tip; ventral surface clothed, from the upper breast posteriorly, with very soft, thick, fine woolly fur, which over the whole pectoral region is pure white to the base, but along the sides and posteriorly is at the base pale plumbeous; a broad prepectoral band dusky grayish brown; chin and throat plumbeous with the fur broadly tipped with white, giving a grayish white superficial tint; sides of the nose and edge of upper lip pale rusty buff; tip of nose dusky, followed as far back as the eyes by a broad facial band of gray; top of head like the back but rather darker; sides of head from nose to base of ears pale grayish rusty buff; ears internally blackish brown washed with pale rust, becoming more fulvous at the tips, which are edged with black; outer border of ears edged with white for the basal three fourths, the white diminishing in amount from the base apically; posterior surface of ears broadly whitish on the outer half, passing into buffy gray on the inner half with the dusky base of the hairs showing more or less at the surface; tail above gray mixed with blackish, under surface of tail light gray; upper surface of fore feet pale yellowish brown, the under surface whitish, adventitiously stained yellowish; hind feet white externally, yellowish brown on the inner edge and on the toes; soles clothed with dusky hairs, the toes yellowish.

An adult female, taken May 28, is still partly in winter dress, but on the head and back the summer pelage is well developed, though thinly veiled in places by the left-over white hairs of the winter coat, while the nape, shoulders, sides, and whole ventral surface are still heavily covered with the winter coat. The general color of the new, short, summer coat is dark grayish brown suffused rather strongly with buffy yellow. The sparse underfur is pale buffy gray; the longer hairs are broadly banded near the tip with dark brown and tipped with yellowish. The upper surface of the head is rather more yellowish than the back, and the sides are darker, more grayish brown and less yellowish than the back, while the lower back and rump are dark gray. The ears are still mostly white, but the tips have changed from black to dull yellowish brown. The tail is still wholly white, and the feet have undergone little change from the winter dress.

A male taken October 1 has nearly completed the change to winter dress. The top of the head and the back show traces of the summer coat, there being a strong mixture of yellowish brown and black-tipped hairs on the crown, and a slight sprinkling of similar hairs over the middle region of the back.

In full winter dress the pelage is very thick and soft and, including the underfur, pure white to the base, except the ears, which are very narrowly tipped with black.

This southern form of the Siberian Arctic Hare is represented by 24 skins and skulls, 2 additional skins, 2 skeletons, and 14 additional skulls, taken in the vicinity of Gichiga by Mr. Buxton. They are all in white winter pelage except three, and were collected as follows: Oct. 1, 1; Nov. 5 and 6, 2; Jan. 11, 7; Feb. 1, 12; Feb. 15, 12 (skulls only); July 27, 1 (young).

The weight of three specimens, as recorded by Mr. Buxton, is, respectively, 7½, 8, and 8¼ pounds. Whether these were of average size or exceptionally large is not stated.

The table on page 158 gives the external measurements of 20 adult males and 17 adult females, taken by Mr. Buxton from the fresh specimens, and also the two principal measurements of the skull. The range of variation is not very large, and is due in part to immaturity, the smaller specimens being shown by the skull to be the younger members of the series. The females average slightly smaller than the males, except in respect to the length of the tail which, as often happens in other species, is longer in the females than in the males.

It is probable that the Arctic Hares of Europe and Asia are all referable as subspecies to *Lepus timidus* Linn., but in the absence of material for their investigation the Siberian forms are treated under binomial names. *Lepus canescens* of Nillson, from southern Scandinavia, is said to have a similar representative in the Stanovoi Mountains of southeastern Siberia, and indeed by some writers, as Middendorff and Radde, they have been considered as indistinguishable. It seems, however, probable that very appreciable differences would be found on comparison of adequate material from the two reigons. Nordquist has considered the Northeast Siberian form as a variety of *L. timidus*, for which he has proposed the name *Lepus timidus* var. *tschuktschorum* (Vega-Exped. Vetensk. Iakt., II, 1883, pp. 84–90). The form here described differs from the latter in considerably smaller size, less massive skull, much lighter dentition, and apparently a more

tawny summer pelage. The cranial differences and the difference in size are shown by the single specimen from Chaplin Point, extreme northeastern Siberia, described below.

MEASUREMENTS OF *Lepus gichiganus*.

Mus. No.	Sex.	External Measurements.			Skull.	
		Total Length.	Tail Vertebræ.	Hind Foot.	Total Length.	Greatest Zygomatic Breadth.
18279	♂	595	54	170	—	—
18280	♂	600	86	159	42.5	49
18282	♂	570	61	156	94	48
18285	♂	555	50	166	91	47.5
18286	♂	584	75	173	93	49
18289	♂	582	60	159	91	49
18290	♂	593	76	166	95	49
18291	♂	624	77	167	—	—
18292	♂	597	80	162	93	48
18293	♂	565	75	170	93	48.3
18294	♂	583	74	162	95	50
18296	♂	594	79	165	99	42
18298	♂	562	76	163	95	50
18299	♂	565	81	164	97	50
18303	♂	552	74	159	—	—
18307	♂	576	81	159	90	46
18308	♂	580	70	163	93	48
18309	♂	620	76	167	98.5	48
18312	♂	590	74	173	92	48
18314	♂	558	74	160	92	48.3
18281	♂	585	76	167	91	47
18283	♀	563	61	156	91	45.3
18284	♀	562	61	146	88	45
18287	♀	552	73	160	91	48
18288	♀	558	69	155	90	47
18295	♀	588	85	165	94	49.7
18297	♀	562	76	159	91	47
18300	♀	563	82	168	90	49
18301	♀	590	80	167	92	49
18304	♀	560	80	169	—	—
18305	♀	575	71	160	90	47
18306	♀	573	79	164	—	—
18310	♀	570	68	160	88.5	47.5
18311	♀	568	81	162	95	48
18313	♀	550	69	156	—	—
18315	♀	555	75	166	91	46.5
18316	♀	575	77	168	92	47
Average of 20 adult males		582	66.6	164	94	48.7
Average of 17 adult females		577	74	162	91	46

"Russian name, *Zaisch;* Siberian name, *Oo-skon.* An abundant resident in suitable localities at all places that I visited in Northeast Siberia. I saw it at Okhotsk, Ola, Gichiga, and Marcova. Mr. Jochelson says that it is abundant along the Kolyma River and its tributaries, and that a few [*Lepus tschuktschorum*] were found near the New Marine Post at the mouth of the Anadyr. Along all the streams, and wherever there was a growth of trees or bushes between Gichiga and Marcova, I saw evidences of them. In many of these places the snow was simply packed down by their feet and littered with their droppings. They are especially fond of the bark of the young willows, and I have seen sprouts entirely stripped of the bark for a distance of three feet above the snow, and others over two inches in diameter entirely gnawed in two. They are never seen during the day unless startled from their burrows in the snow-drifts or under fallen trees, but they are very active at night, especially clear ones. They seldom stray far from their feeding-grounds and are never seen on the open tundra. The Russians catch them during the winter in deadfalls and use the meat for food and the skins for bedclothing. Every family has a number of bed blankets made from their skins, and they are very warm and serviceable. A skin has a local value of about 5 cents." — N. G. B.

20. **Lepus tschuktschorum** (*Nordquist*).

CHUKCHE HARE.

One specimen, in full winter pelage, obtained at Chaplin Point (Indian Point of Americans), extreme northeastern Siberia, by Mr. W. Bogoras, the date being "Fall, 1901." No measurements were taken from the fresh specimen, but such measurements as can be obtained from the skin show it to be larger than the average size of *L. gichiganus*, slightly exceeding even the largest specimens of that form. Thus, the ear from the crown measures 13 mm. longer than the average length in *gichiganus* and 8 mm. more than the largest; while the hind foot (measured in the dry skin in each case) is 10 mm.

longer than the average in *gichiganus* and slightly exceeds the largest. The skull is much more massive, though only slightly exceeding in dimensions the largest skulls of *gichiganus;* the incisors are broader and thicker and the molars broader and heavier, as are also the zygomatic arches. The lower jaw is also broader and heavier.

21. **Erignathus barbatus** (*Fabricius*).

BEARDED SEAL.

This species is represented by four adult specimens (skins with skulls) collected by Mr. Buxton at Gichiga, Sept. 4, 1901, and two young adults collected by Mr. Bogoras at the mouth of the Anadyr. They do not differ appreciably from Greenland specimens, either in size or other features. Three of the four specimens are females and the other is a male. The male skull has a basal length of 213 mm. and a zygomatic breadth of 122; two of the female skulls (one is much broken) measure, respectively, 205 x 125 and 220 x 137 mm.

The external measurements of three of the specimens, taken in the flesh by Mr. Buxton, are as follows:

	No. 18166 ♂	No. 18164 ♀	No. 18165 ♀
Length..	2300	2095	2600
Girth..	1375	1410	1655
" of head..	600	605	620
Distance between the eyes.	90	75	90
Tail..	215	215	275
Hind foot..	350	390	420

"Local name, *Nerpah;* also sometimes called *Locktock*, which is the name generally applied to it in Kamchatka. Also usually called Locktock at Marcova. A common winter resident in Okhotsk Sea and along the eastern coast of Siberia from Petropavlovsk to East Cape, and probably along the whole northern coast. Mr. Jochelson has seen it at the mouth of Kolyma River in summer. At Gichiga it is quite common, especially during July, August, and September, but does not ascend the rivers until after the 1st of August, and then only in small numbers. Mr. Sokolnikoff has observed it

during August in the Anadyr River, more than 400 versts above its mouth. All the specimens that I saw at Gichiga were much lighter in color than Point Barrow, Alaska, specimens, and not so uniformly colored. At Gichiga a skin is valued at five roubles." — N. G. B.

22. **Histriophoca fasciata** (*Zimmermann*).

RIBBON SEAL.

Represented by a flat skin obtained by Dr. Berthold Laufer on the Lower Amoor River.

"Local name, *Kre-lat-ah* and *Mandar-ka.* Although this seal does not occur at Gichiga, the people there are well acquainted with it and many possess travelling bags made from their skins, which have been obtained from Oliutorski and Baronesskorf Gulfs, where they are common. Mr. Jochelson said that the Koryaks living along Penginski Gulf have taken an occasional one there, but I consider it very doubtful. Mr. Sokolnikoff says that they are common far out in Anadyr Gulf, but never come close in to shore or ascend the Anadyr River." — N. G. B.

23. **Phoca (Pusa) hispida gichigensis** Allen.

OKHOTSK RINGED SEAL.

Two skins and skulls of young females (see this Bulletin, XVI, 1903, pp. 478–480). Mr. Buxton's notes respecting this species are as follows:

"Local name, *Ak'-ee-pah.* A small seal, of which I saw very few. After the ice began to form in the river about the first of October, and was daily crushed up by the tide, I saw a few of this species swimming in the ice-gorged river opposite my station, and during the summer I saw a few off Matuga Island. The people say they do not come into the rivers until the ice begins to form. In February, 1901, I saw one in a Koryak lager at Shestacova, that had just been killed.

"Mr. Sokolnikoff has seen this species in the Anadyr River, 25 versts below Marcova, in summer. Their skins are in but little demand, as those of the other two species are much better and larger." — N. G. B.

24. **Phoca ochotensis** *Pallas.*

OKHOTSK SEAL.

Five specimens (skins and skulls), collected by Mr. Buxton on the Taiganose Peninsula, 20 miles south of the mouth of the Gichiga River. These are therefore topotypes of Pallas's *Phoca ochotensis*, his description of which is sufficiently explicit to render its application to the present species satisfactorily evident, as elsewhere explained (*cf.* this Bulletin, XVI, 1902, pp. 480–482). A skeleton collected by Dr. Laufer at the mouth of the Amoor River is also referred to the present species.

"Local name at Gichiga, *Ola;* at Okhotsk, Ayan, Pengina, and Marcova, *Largha.* This is by far the most abundant species of the hair seals found in the Okhotsk Sea. I saw them at Udskoi Bay, about the Shantar Islands, at Ayan, Okhotsk, Ola, Gichiga, and at Shestacova on Penginski Gulf. It, together with the other two species occurring at Gichiga, is a resident in the Gichiginski Gulf. As soon as the rivers flowing into the head of this gulf free themselves from ice, about the first of June, the Larghas ascend them at high tide as far as slack water, some four or five miles above their mouths, and again go out with the tide. They do not become common in the rivers until the first of July, when the salmon begin to run in considerable numbers, and do not reach their maximum of abundance until two or three weeks later, when the salmon have become abundant. At this time hundreds of them come in with the tide, especially when there is one per day and that occurring after midnight. At that time many go far up the river, while hundreds of them remain near its mouth, where they catch fish and 'haul out' on the low banks and islands at that point, when their snorting and growling can be heard far up the river. It is possible to shoot many of them in the river, but very few can be secured there, as they sink immediately and the strong current carries them out to sea. At high tide off the river's mouth one can see vast numbers of them catching fish. Dozens of them stick their heads out of the water, some with fish in their

mouths, within a stone's throw of your boat, and gaze in mild-eyed astonishment at you for a few seconds, give a snort, and disappear. Salmon can be seen jumping clear out of the water in all directions in their efforts to escape the seals. The Koryaks and Tunguses pitch their tents during July and August along the head of the Gichiginski Gulf at places where streams flow in and get many of these and of the Bearded Seal by shooting them from bidarkas and spearing them with retrieving harpoons along the rocky headlands.

"Catherine Gulf, 40 miles southwest from Gichiga on the mainland coast, is a long tongue-like indentation in the precipitous coast-line, 200 yards wide and a mile long. At low tide the water in it is quite shallow, and many rocks on its bottom and along its side are exposed. On the morning of August 11, 1901, I came suddenly on this little gulf while down the coast goose shooting, and every one of the hundreds of available rocks in it was occupied by seals — mostly this species and a few Bearded Seals — basking in the bright sunlight. At the report of my gun they all slid into the water and started for the open sea.

"Hair seals are much more abundant in the Okhotsk Sea than they are at any point along the Alaskan coast. They form a considerable part of the food of all the people, natives and Russians, living near the Okhotsk Sea, as they do of all the people inhabiting the high north. The skins of this species have a commercial value of one rouble each at Gichiga, and are used for boots, lines, and dog harness.

"Mr. Sokolnikoff assured me that in summer it ascended the Anadyr River nearly to Marcova." [1]— N. G. B.

25. **Ursus beringianus** (*Middendorff*).

KAMCHATKA BEAR.

The collection contains five more or less imperfect flat skins of bears, only one of which has a skull. They probably all belong to one species, the variation in size and color being

[1] This statement refers to the subspecies *Phoca ochotensis macrodens* Allen. See this Bulletin, XVI, 1902, pp. 483–485.

probably due to sex and age, three of the specimens being young.

The best specimen is No. 18275, male, represented by a nearly perfect skin and skull. It was killed on Baronesskorf Gulf (Olutorski Bay of some maps), and purchased of the natives by Mr. Bogoras. This specimen is referred to Middendorff's *Ursus arctus* var. *beringiana*. The specimen he describes and figures under this name, he informs us, came from Great Schantar Island, which is situated in the western arm of the Okhotsk Sea (Uda or Udski Bay), so that this island may be taken as the type locality of the species. Another specimen is figured and described from "Uda-Bucht," at the mouth of which is situated Great Schantar Island. The locality of the present specimen is on the east coast of Siberia, nearly opposite the head of Okhotsk Sea.

The specimen is obviously in full winter pelage and is a beautiful skin. The general color is very dark reddish brown, darker, or blackish brown, on the limbs. The hairs on the back are tipped with lighter, the light tipping increasing rapidly in length from the middle of the back anteriorly, and becoming lighter in color, so that over the shoulders the prevailing color is yellowish brown, passing on the nape and crown into pale golden fulvous. The front of the head, from the forehead anteriorly, is dark brown with a tinge of fulvous, particularly on the sides of the nose anterior to the eyes. The claws are strong and curved, those on the hind feet much worn. The longest front claws have a length of 70 mm. along the convexity, and 45 along the arc; the longest hind claw measures 40 mm. over the convexity and 17 along the arc. The length of the flat skin is 1975 mm.; the expanse from tip to tip of the extended fore limbs, 2271 mm.

The skull indicates a middle-aged animal, the sutures being still quite distinct and the teeth almost wholly unworn. Its striking features are the great breadth of the frontal region, the swollen postorbital processes, and the deep median hollow between them. Compared with skulls of *Ursus middendorffi* Merriam, from Kadiak Island, of corresponding age and sex, the breadth of the skull is much greater in proportion to its

length, the anterior narial opening is much shorter, and the molars differ in relative size and form. It much more resembles in general contour and proportions the skull of the Barren Ground Bear (*Ursus richardsoni*), as perhaps should be expected. The present skull measures: Total length, 390 mm.; basal length, 355; zygomatic breadth, 235; interorbital breadth, 105; breadth at postorbital processes, 141. These measurements are much less than those given by Middendorff of a very old skull from Great Schantar Island, and slightly less than those of his 'middle-aged' skull from Uda-Bucht.

A second flat skin, No. 18176, without skull or data, is similar to No. 18175, except that it is rather smaller and less dark, with a distinct shade of gray over the posterior half of the back, and the shoulders, nape, and top of the head are paler fulvous. Two much smaller skins, evidently of quite young animals, are very dark brown, like the adult male first described, with the light tips of the hairs of the posterior back gray, and of the front part of the dorsal region and head yellowish gray, but very much less fulvous than in the adult. One of these specimens (obtained by Mr. Bogoras at Marcova) has a broad transverse band of white across the hind neck, and a small white spot on the middle of the belly, due apparently to albinism.

A third small flat skin, probably young of the year, labelled as from Marcova, without a skull, is widely different in coloration from any of those above described. The ears, limbs, sides, and ventral surface are dark brown, tinged slightly with gray; the dorsal region is gray, becoming brighter anteriorly, the nape being pale fulvous, and the crown and cheeks pale golden fulvous. This could well be called a 'yellow' bear. Mr. A. J. Stone suggests to me that its light color indicates that it is a female, as he has found that the female of the great Alaska Bear differs from the male, just as this specimen differs from the other specimens of this series.

"Russian name, *Mĕd-vêhd.* Bears are undoubtedly very common in the country around the head of Okhotsk Sea, as well as in the Anadyr and Kolyma River territories, along

the western seacoasts, and in Kamchatka, for all of the people in these districts tell of their great number, although one sees comparatively few skins. Notwithstanding the high prices that I offered for specimens in the flesh, or with skull and leg-bones attached, I received none, although during the summer of 1901 I heard reports every few days of the Russians seeing bears along the upper waters of the Gichiga and Ovecho Rivers. In September, 1900, I saw tracks along the Ovecho. At Gichiga they come out of hibernation about the first week in April, and at Marcova about two weeks later, and again retire the first of October. The Russians claim to be afraid of them on account of the poor firearms that they possess, and seldom attack them. The natives — Tunguses and Koryaks — locate them in winter by the vapor arising from their dens and dig them out. The Parane River, which flows into Penginski Gulf, is said to abound in small black bears. All the pelts I saw in Northeast Siberia are those in the collection. A good dark pelt brings from 10 to 15 roubles in trade or cash. Their food consists of fish and berries, both of which are abundant and easily obtained." — N. G. B.

26. **Canis lupus** *Linn.*

Gray Wolf.

Represented by 5 skins, with their skulls, collected on the River Main, 60 miles from Marcova, by Mr. Axelrod, and by 3 skins without skulls, obtained by Mr. Bogoras near the mouth of the Anadyr River. No measurements were taken of any of the animals before skinning. They are all winter specimens, those taken near Marcova having been killed in December and February. They vary somewhat in color, particularly in the amount of black, due to the black tips of the hairs of the back, and the amount of subapical yellowish suffusion on the median area of the back. In one or two of the specimens the amount of black is very small, and in others black is the prevailing tint. In the lightest colored specimens the subapical zone of the fur is nearly or quite without any fulvous tint; in other specimens the hair of the mid-dorsal region is subapically strongly suffused with fulvous, varying

in different specimens to pale ochraceous, and in the extent of the area thus suffused, which is broadest in those with the deepest suffusion. The ears are more or less yellowish brown, most strongly so toward the base, the depth of the yellowish brown tint correlating with the intensity of the yellow suffusion of the dorsal region.

The skulls show the specimens to be young adults, with the teeth unworn and the sagittal and occipital crests only slightly developed. They range in basal length from 203 to 221 mm., and in greatest zygomatic breadth from 108 to 126 mm., both extremes being females. Compared with the northern forms of American wolves, their small size and the narrowness of the postpalatal fossa attract attention.

Lack of material prevents comparison of the series of East Siberian wolves with those of other parts of the Palæarctic region.

"Russian name, *Volk*. Wolves are extremely rare if present at all in the Gichiga country. In the Anadyr territory and along the west coast of Okhotsk Sea and inland they are common. The supply of skins received at Gichiga does not equal the local demand for them for making clothing, but at Marcova a few can always be purchased. The people of Gichiga and Marcova recognize but one species, although a priest at Ola assured me that two species were found inland from that place. All of the skins in the collection are from Anadyr." — N. G. B.

27. **Vulpes anadyrensis,** sp. nov.

SIBERIAN RED FOX.

Type, No. 18239, ♂ ad., Marcova, Anadyr Province, Siberia, Dec. 10, 1900; N. G. Buxton, Jesup North Pacific Expedition.

Similar in size and coloration to *Vulpes alascensis;* much larger than *V. vulpes* of the British Islands and western Europe, and very differently colored, with a relatively much longer and heavier tail, and much heavier dentition.

General color above bright orange rufous, darkest along median line, lighter on the sides of the shoulders, sides of the neck and cheeks, and sides of the rump, and slightly varied with gray on the head and hips; nose in front of the eyes rufous, sides of nose blackish, upper lip broadly edged with white; top of head lighter than shoulders and back,

very slightly varied with fulvous gray; apical external half of ears black, basal half and inner surface pale orange; posterior third of dorsal surface rufous varied with fulvous gray, much lighter than the anterior half of the body, and with a pale orange disk in front of the base of the tail, divided by a median band of the color of the back; ventral surface from chin to lower part of breast white, with the underfur blackish or slaty gray; rest of ventral surface rufous, lighter posteriorly, with the underfur along the median line dusky, showing strongly at the surface on the middle of the belly; tail dark rufous orange, the long hairs tipped with black, so that the sides of the tail when seen from above are strongly fringed with black; end of the tail broadly tipped with pure white; fore and hind limbs deep rufous, with the front surface of the fore feet black to the carpal joint, and of the hind feet black nearly to the tarsal joint, the black area narrowing proximally on the latter from the middle of the foot; base of the toes deep orange rufous; soles of both fore and hind feet brownish gray with a slight rufous tinge.

For external measurements see below, and for cranial measurements see page 170.

Vulpes anadyrensis is so strikingly different in coloration and size and in its heavy dentition from *Vulpes vulpes* of western Europe and England that no further comparison is necessary. In size and general external features, and in its heavy dentition, it bears a striking resemblance to some of the brighter colored phases of the Red Fox group of Alaska, but it is very much more deeply colored, being orange rufous above instead of fulvous or golden fulvous, with the nose, feet, and other lighter parts proportionately deeper colored.

The skull is less massive and narrower interorbitally, but the dentition is quite as heavy as in the largest Alaskan skulls.

This species is represented by 9 skins with skulls, taken in the vicinity of Marcova by Axelrod and Buxton, and by 17 hunters' skins purchased by Mr. Bogoras of the natives at Indian Point. Five of the Marcova specimens measured in the flesh as follows:

18239,[1]	♂, Dec. 10.	Total length,	1120;	tail vertebræ, 425;	hind foot, 166.
18240,	♀, " "	" "	1065;	" " 374;	" " 168.
18244,	♂, Apr. 7.	" "	1078;	" " 430;	" " 157.
18241,	♀, Feb. —.	" "	1005;	" " 362;	" " 170.
18245,	♀, Apr. 24.	" "	1030;	" " 410;	" " 165.

[1] Type.

Eight of the Marcova skins represent the usual red phase, while the other is a 'cross' fox. In the red phase the general color above varies from light to dark red, lighter and brighter anteriorly, with a slight mixture of gray on the top of the head and lower back; the apical half of the ears is deep black; the anterior surface of the feet and apical half of the fore leg is black or blackish, mixed more or less with rufous, as is the upper surface of the hind feet, where the black extends up from one third to two thirds the length of the tarsus, narrowing proximally; the upper surface, and sometimes the lateral surface of the tail is conspicuously washed with black, with the extreme tip white. The ventral surface is quite variable in respect to the amount of white present, which covers the sides of the upper lip, the chin, throat, and breast, with the underfur of the throat and breast more or less slaty black; there is often a less well-defined whitish area over the extreme posterior ventral surface, and sometimes an irregular whitish median band connects the broad white area of the throat and breast with the smaller white anal area.

In the 'cross' specimen the whole ventral surface is black, — deep black on the chin, throat, and breast, and brownish black over the rest of the ventral surface; edges of the upper lip, and the sides of the face in front of the eyes also black, and the feet and limbs are more extensively brownish black than in the red phase. The dorsal surface is dark reddish brown varied posteriorly with gray, — not yellow as in the Alaskan 'cross' fox. The tail is also more heavily washed with black, with, however, the usual white tip. The sides of the shoulders and chest, the sides of the neck, and the area at the anterior base of the ears, and at the sides of the base of the tail, is much lighter than the general coloration, being in this example bright yellowish rufous, becoming rich orange rufous at the anterior base of the ears, but lightening to pale yellow at the sides of the base of the tail.

The following are the measurements of the series of skulls from Marcova.:

MEASUREMENTS OF SKULLS.

Cat. No.	Sex.	Date.	Basal Length.	Palatal Length.	Postpal. Length.	Nasals.	Zygom. Breadth.	Interorb. Breadth.	Breadth of Rostrum.	Pm. 4, along Outer Border.
18239[1]	♂	Dec. 10	142	72	70	59	80	26	23	15
18240	♂	" "	138	68	67	55	74	28	24	14.3
18242	♂	" "	136	69	66	55	72	27	24	14
18244	♂	Apr. 7	140	71	70	52.5	79.5	29.5	24	13.6
18246	♂	Dec. —	135	—	—	—	74	28	22	13.6
18245	♀	Apr. 24	141	71	68	54	75	25.5	22	14
18243	?	Dec. —	132	—	—	—	73	—	23	13.5

[1] Type.

"Red Fox. Russian name, *Lee-see-sha.* None of the foxes are abundant or even common in the Gichiga valley although, comparatively speaking, the red form is the commonest there, as it is in the Anadyr Province. The traders at Gichiga and Marcova receive each year a large number of pelts from the inland natives and from the Koryaks inhabiting the country lying between these two places and the Chukchees, to the north and west of Marcova. Many are also received at Gichiga from the country lying along the west coast of Okhotsk Sea. The people employ native traps to catch them, and also resort to the illegal use of strychnine when they can obtain it.

"I saw no foxes nor any signs of them at Gichiga although I saw many tracks along the Pengina, Ocklon, and Orlofki Rivers during February and March, 1901. Pelts bring from 4 to 5 roubles each.

"Cross Fox. Russian local name, *See-woy-dóos-ka.* Cross foxes are rather common all over that portion of Northeast Siberia where the red fox occurs, and a considerable number of pelts are annually received by the traders at the different settlements. The average price is 15 roubles each.

"Black or Silver Gray Fox. One poor, mutilated pelt was received by a trader at Gichiga from Yamsk in the spring of

1901, which was valued at 40 roubles. One taken at Ayan in the winter of 1899–1900 sold in the market for 1500 roubles." — N. G. B.

28. **Vulpes lagopus** (*Linn.*).

ARCTIC FOX.

Represented by one specimen, in 'blue' coat, taken April 1, 1901, at Kamenskoi, on Penginski Gulf; by 4 specimens taken at Marcova, in December, by Mr. Axelrod; by 12 winter specimens collected by Mr. Bogoras at the mouth of the Anadyr River, and by 18 hunters' pelts bought by Mr. Bogoras of the natives at Indian Point. Of these 35 skins 12 only have skulls, and one only has measurements or indication of sex. This specimen, a male, taken at Marcova, March 10, 1901, measures: Total length, 940; tail vertebræ, 345; hind foot, 150. No. 18248, from the mouth of the Anadyr, without date, is apparently in summer coat, the pelage being ragged and more or less worn. The general color above is soiled yellowish white, with the underfur dingy gray or grayish brown. The ears, and the fur surrounding them, are dull chestnut brown; the nose as far back as the eyes, a broad space enclosing the eyes, and the chin, are dusky brown. The ventral surface is dusky grayish brown, darker and more rusty on the anterior half. The feet and legs are dull rusty brown, the apical portion of the hairs lighter and more yellowish.

The winter specimens are superficially white, or slightly yellowish white, with the thick woolly underfur more or less tinged with gray at base, the amount of gray varying in different specimens, from nearly none to a strong infusion. Some of the specimens show a slight mixture of blackish hairs overtopping the general surface.

The April specimen in 'blue' coat from Penginski Gulf is dull dark brown all over, with a slight reddish tinge, with the underfur light gray, and the soles of the feet whitish. This is the 'blue' fox pelt referred to by Mr. Buxton in his notes. It apparently is not a seasonal condition, as the pelage is long

and full and in excellent condition, and apparently the winter coat. This phase is probably a melanism, comparable to the 'black' or 'silver gray' phase of the red fox.

The ten skulls available for measurement range in total length from 114 to 126 mm., averaging 120, and in zygomatic breadth from 64 to 70, averaging 68.

"Arctic Fox. Russian local name, *Pee-seetz-(a)*. This is the next common of the foxes in the Gichiga and Anadyr regions. The bulk of the skins come from the country north of Marcova where it is abundant and the commonest form. It prefers the barren tundra to the wooded portions of the country and therefore ranges further northward. More of this species are received at Marcova than at Gichiga and other settlements further south. Pelts are valued at from three to four roubles each.

"Blue Fox. Russian local name, *Gol-o-bah pee-seez-(a)*. An occasional pelt is received at Marcova and Gichiga. The one in the collection was caught on a small river flowing into Penginski Gulf. I saw another pelt at Marcova taken at a place 100 miles northeast of that place. They are valued at 15 to 25 roubles each." — N. G. B.

29. **Gulo gulo** (*Linn.*).

WOLVERENE.

This species is represented by a skin, without skull, obtained by Mr. Axelrod, at Marcova, in the Anadyr Province, and by two young cubs obtained by Mr. Buxton near Kamenskoi, on Penginski Gulf. The cubs have a total length of about 400 mm. and could have been but a few weeks old. As shown by the skulls, the teeth had not yet pierced the gums. They are, of course, in the soft woolly pelage characteristic of extreme youthfulness, and while very different in coloration from the adults, they have the same color pattern. The light areas are pale yellowish white, more strongly yellowish on the rump and ventral surface than elsewhere; the dark areas are ashy brown, in strong contrast with the light areas.

The skin from Marcova, taken in December, has the dark areas nearly black, and the light markings white tinged with rusty; the specimen is thus darker than in average North American skins, but not darker than some of the darkest specimens now before me.

"Russian local name, *Rŭs-so-mākāh*. This mammal is now not found, or at least very rarely, in the vicinity of Gichiga. In Anadyr Province it is tolerably common. One was obtained by Mr. Axelrod from hunters there which is in the collection, and I saw one that had been taken in March, 1901, near Marcova. The two young in the collection were caught near Kamenskoi, on Penginski Gulf, but I could obtain no particulars concerning their capture. They are reported plentiful in Kamchatka, and pelts bring but 5 roubles in Petropaulsk, while at Marcova and Gichiga they are worth from 10 to 20 roubles each. They are used by the Russians and natives for trimming fur garments." — N. G. B.

30. **Mustela zibellina** *Linn.*

SABLE.

This species is unrepresented by specimens. As shown by Mr. Buxton's notes, here subjoined, it has been exterminated in the region about Gichiga.

"Russian name, *Só-bel*. No Sables are found in the immediate vicinity of Gichiga, although from thirty to fifty pelts are received there annually, principally from the Pengina River region and northern Kamchatka. Mr. George H. Storck, a furrier of New York City who visited Gichiga in June, 1901, purchased thirty-five skins from a local trader for 35 roubles each, and the commanding officer at Gichiga had six. Mr. Storch said that these skins were of better quality and darker than skins from southern Kamchatka, of which he had examined several hundred for sale at Petropauvolsk. Mr. Sokolinkoff, the commanding officer at Marcova, had ten pelts from the Pengina district when I visited him in March, 1901. The average price is from 30 to 40 roubles each." — N. G. B.

31. **Putorius (Arctogale) ermineus** (*Linn.*)

Ermine.

Represented by 20 adult males and 1 adult female (skins and skulls) collected by Mr. Buxton in the vicinity of Gichiga, all in the white winter pelage except one. One was taken in January, 6 in April, 2 in October, 5 in November, 6 in December, and 1 (in summer dress) in August. Besides these there are 10 skins with skulls, brought by Mr. Bogoras from the mouth of the Anadyr River, and 9 specimens in alcohol collected by Mr. Jochelson near Verkhene Kolimsk, on the Kolyma River.

The length of the black tip to the tail is variable, ranging from 65 mm. to 95, and averaging about 75, or from considerably less than half to considerably more than half of the whole length of the tail. The same range of variation is shown by a large series of *P. richardsonii* from Repulse Bay, Arctic America. These two large series show that the relative length of the black tip to the whole length of the tail is too variable a feature to have much importance in the consideration of single specimens from different localities. There is also a wide range of variation in the amount and depth of the yellow suffusing the pelage of the ventral surface, the limbs, and the basal portion of the tail. Some specimens show none, and others merely the slightest tinge, restricted to the limbs and edges of the ventral surface, while in still others the tone of yellow approaches deep chrome and covers the whole ventral surface, from the posterior border of the pectoral region to the black portion of the tail, including both fore and hind limbs, the rump, and the basal half of the tail. Several of Mr. Buxton's specimens show no tinge of yellow; nearly all of Mr. Bogoras's are either wholly without yellow or show only the slightest trace, while some of Mr. Jochelson's are without and some have a very deep shade of yellow. The single specimen in summer pelage has the whole ventral surface strongly yellow, including the breast and throat. A series of 14 specimens of *P. richardsonii* in winter pelage show little or no yellow, while 22 in summer pelage all show more

or less yellow, varying in different specimens from a faint tinge to deep yellow.

I add herewith the external measurements of 21 specimens taken by Mr. Buxton from the fresh specimen, and include therewith the three principal skull measurements, so far as the skulls are available for this purpose, a few of them being too imperfect for measurement.

MEASUREMENTS OF *Putorius ermineus*.

Cat. No.	Date.	Sex.	External Measurements			Skull Measurements.		
			Total Length.	Tail Vertebræ.	Hind Foot.	Total Length.	Zygom. Breadth.	Mastoid Breadth.
18324	Aug. 6	♂	315	88	43	—	—	—
18325	Oct. 23	♂	333	100	48	—	—	—
18326	" 30	♂	357	102	50	47.3	27.3	23.3
18327	Nov. 4	♂	333	97	51	47	27	23
18328	" "	♂	313	83	50	45.5	25.6	22.7
18329	" 15	♂	317	85	47	45.3	24	21.5
18330	" 23	♂	305	82	44	—	—	—
18331	" 24	♂	316	90	44	44	23	20.2
18332	Dec. 13	♂	365	102	54	48	27.6	23.5
18334	" 2	♂	347	102	51	45	25	23
18335	" "	♂	350	99	48	47	27	23
18336	" "	♂	345	95	48	46.5	26.3	23.8
18337	" 20	♂	335	92	45	44	24	22.5
18338	" "	♂	340	91	47	—	—	—
18339	April 5	♂	325	88	45	—	—	—
18340	" "	♂	312	74	43	—	—	—
18341	" "	♂	312	79	42	—	—	—
18342	" "	♂	318	93	49	44	24	22
18343	" 13	♂	328	93	49	45.5	25.6	22.3
18344	" 24	♂	328	83	45	—	25.3	22
18333	Jan. 12	♀	278	73	38	39.8	21	19.6
20 males average			325	90.5	47.4	46	26.5	22.6

Material from northern Europe available for comparison with the Siberian series is too scanty — four specimens only — to be of any importance, but so far as it goes the specimens from northern Europe do not differ appreciably from those from northeastern Siberia.

Externally the Siberian animal does not differ noticably from *P. richardsonii* from eastern Arctic America, of which I have some 30 skulls and nearly 40 skins, collected in the vicinity of Repulse Bay (a northwestern arm of Hudson Bay).

The Repulse Bay specimens, however, are without measurements taken from the fresh specimen, and are thus in respect to size and proportions not satisfactorily comparable with the Siberian specimens. The Repulse Bay specimens in summer coat are extremely variable in coloration, ranging from light yellowish brown to dark brown. There are, however, very marked differences in the skulls of the two forms, in *P. ermineus* the skull being long and narrow, with a low, elongate, narrow braincase, in comparison with the much broader skull of *P. richardsonii*, and relatively much deeper and much broader braincase. The skull in *P. richardsonii* averages considerably smaller than that of *P. ermineus* and has shorter, less flattened, and more widely separated bullæ.

It is interesting to note that in the Buxton series of 21 specimens only one is a female, and that there is also only one female in a series of 38 specimens from Repulse Bay. It would thus seem that the females are better able than the males to escape the wiles of the trapper.

"Ermine. Russian name, *Gór-no-stai-e*. Quite common at all the places that I visited in Northeast Siberia, although by no means abundant. They are most common in winter about the Russian and native settlements, where they are attracted by the fish and meat stored at such places. In a small outbuilding near my cabin I had a number of gulls and deer carcasses stored, and during the winter I caught ten ermines in one trap that was set there, while from a line of baited traps maintained on the tundra and under other buildings in the settlement all the time (thirteen months) that I was at Kooshka I took only one. The distinct sulphur color of many of the winter skins was more or less present in the fresh specimens, but has increased in intensity since being prepared. The pelts are valued at from 20 to 30 kopecks each." — N. G. B.

32. **Putorius (Arctogale) pygmæus,** sp. nov.

PIGMY WEASEL.

Type, No. 18322, ♀ ad., skin and skull, Gichiga, west coast of Okhotsk Sea, Siberia, Oct. 2, 1900; N. G. Buxton, Jesup North Pacific Expedition.

Summer pelage.— Above dark reddish brown, including the anterior surface of the fore limbs to the carpus, and the outer surface of the hind limbs to the base of the toes; ventral surface, inside of the limbs, fore feet, and apical half of hind feet white, the ventral surface unmixed with any brown mottling; edge of upper lip and lower half of cheeks white, like the ventral surface; ears very small, brown like the dorsal surface; tail very short, much shorter than the hind foot, wholly brown, uniform with the color of the back, the tip not dusky.

Winter pelage.— Wholly pure white, including the tip of the tail.

Measurements.— Type: Total length, 158 mm.; tail vertebræ, 16; hind foot, 21. *Skull*, total length, 28.5; zygomatic breadth, 13.3; mastoid breadth, 12.5.

A second specimen in summer pelage from Marcova, without measurements and skull imperfect (see Mr. Buxton's notes below), is similar in coloration to the type, but slightly larger and evidently a male.

Besides the two specimens in summer pelage — one from Gichiga and one from Marcova, as already noted — there are two in winter pelage, in alcohol, collected by Mr. Jochelson at Verkhene Kolimsk, on the Kolyma River, in January, 1902. These are male and female, and measure as follows: Male: Total length, 184 mm.; tail vertebræ, 19; hind foot, 23. Female: Total length, 166; tail vertebræ, 13; hind foot, 19.

The measurements given by Mr. Stone for *Putorius rixosus eskimo* (Proc. Acad. Nat. Sci. Phila., 1900, p. 44) considerably exceed those of *P. pygmæus*, being for two males, respectively, total length, 204 and 230; tail vertebræ, 28 and 31; hind foot, 20; while three females range from 178 to 184 in total length, tail 22–25, and hind foot 16–23.

The much smaller size, the very short tail, and greatly reduced ears distinguish this species at a glance from true *P. nivalis*, as shown by a Swedish specimen now before me. Its nearest ally and the only species with which it needs comparison is *Putorius rixosus* Bangs, from Arctic America (type locality, Osler, Saskatchewan), from which it differs in being much smaller, with the tail only half as long as in that species. Mr. Stone's *P. rixosus eskimo*, from Point Barrow, Alaska, is nearer the Siberian form, but differs from it in larger size and in having the tail vertebræ longer than the hind foot instead

of about one third shorter. It is, however, an interesting fact that the present form finds its closest relationship with the *rixosus* group of Arctic America rather than with the Old World *nivalis* group.[1]

"The one specimen from Gichiga was taken in a mouse trap on the tundra near my station at Kooshka. During the year while I was at this station I had from 25 to 100 baited and unbaited traps set continuously, but caught only this one. Some of the residents at Gichiga said that they had never seen the animal before while others maintained that it was a young ermine, so that I consider it rare, at least in the vicinity of Gichiga. The pelt from Marcova was given me by Mr. Sokolnikoff, the commanding officer there, who caught it swimming in the Anadyr River and who said it was the only one that he had seen during his three years there.

"The specimen of *Putorius rixosus eskimo* described by Stone in the McIlhenny Collection from Point Barrow (No. 848), was a nursing female with 10 mammæ developed; another in the same series taken in the middle of June had 12 mammæ developed, and 12 fœtal young in the oviducts." — N. G. B.

33. **Lutra lutra** (*Linn.*).

Otter.

This species is not represented in the present collection. Mr. Buxton's notes respecting it are as follows:

"Russian name, *Vee-drăh.* No otters are now found in the Gichiga country although they undoubtedly occurred there formerly. They are still taken along the smaller tributaries of Pengina and Anadyr Rivers, further inland, and in Kamchatka. I was unable to secure any specimens in the flesh or skulls, but pelts were plentiful at Marcova at from six to ten roubles each. A few pelts are shipped out by the traders each year, but the bulk of them are used by the Russian inhabitants." — N. G. B.

[1] On the Weasels of the *P. nivalis* group, see Barrett-Hamilton, Ann. and Mag. Nat. Hist. (7), V, Jan. 1900, pp. 41–50.

34. **Erinaceus orientalis,** sp. nov.

SIBERIAN HEDGEHOG.

Type, No. 18355, ♀ ad., Vladivostok, Siberia, July 18, 1900; N. G. Buxton, Jesup North Pacific Expedition.

Similar in external characters to *Erinaceus europæus*, but paler and rather larger, with quite different cranial characters. General color of the spiny dorsal area pale yellowish, the spines similar in character to those of *E. europæus*, the individual spines whitish basally with a broad median band of pale brown and a whitish tip. Head, shoulders, and sides pale grayish sandy brown; ventral surface very pale yellowish, thinly haired; head pale brown with a tinge of yellow, and an indistinct whitish spot in front of the eye, enclosed in a slightly dusky area which extends to and covers the sides and front of the nose and most of the head anterior to the eyes; feet dull pale brown, passing into a grayish yellow brown on the limbs; ears small, dusky, about as in *E. europæus;* tail short, dull brown, very thinly haired. Mammæ 6, well developed.

Measurements.— Total length, 312 mm.; tail, 42; hind foot, 50; ear (in dry skin) from notch, 27. *Skull*, total length, 61; zygomatic breadth, 39; postpalatal length, 26.5; length of nasals, 19; length of entire upper toothrow, 30.

This species is based on a single old female (teeth quite worn) bought alive by Mr. Buxton at Vladivostok of a Chinaman, who told him it was caught in Vladivostok. It differs from *E. europæus* in its much lighter coloration, and somewhat larger size, but especially in various features of the skull and teeth. The skull, in comparison with a nearly equally adult skull of *Erinaceus* from Kingsbridge, Devonshire, England, is of nearly the same length as the latter, but much broader and more massive, with the zygomatic arches much more convex outwardly, the two skulls measuring, respectively, 59 and 61 mm. in total length and 34 and 39 mm. in greatest zygomatic breadth. The rostral portion of the skull in *E. orientalis* is much broader, less sloping and less pointed than in *E. europæus*, and the premaxillæ are much broader and heavier, but much less extended and more abruptly truncated posteriorly, their line of junction with the nasals being nearly 3 mm. shorter than in skulls of *E. europæus* of less size, making the relative difference very great. The chief

difference in dentition is the very much larger size of pm^2 in *E. orientalis* and the nearly transverse position of m^3. The palatal vacuities are much broader in *E. orientalis*, and the posterior border of the palate is developed into a broad shelf behind the transverse ridge, thus differing very widely from the same part in *E. europœus*, which extends but little beyond the ridge and terminates in a central sharp spine, which is absent in *E. orientalis*. The lower jaw has about the same general form in the two species, except that the coronoid process is much broader and higher in *E. orientalis*. The lower dentition, however, is quite different in the two, through the very small size of the incisors, canines, and premolars in *E. orientalis* as compared with *E. europœus*.

There appear to be very few references to the occurrence of any species of *Erinaceus* in southeastern Siberia, and in these cases the species is referred to *E. europœus*. Von Schrenck found it near Aigun, on the Amoor River, and Radde refers to specimens collected by Maack and Maximowicz on the Ussuri River, but both Schrenck and Radde considered their specimens specifically identical with *E. europœus*.

There being apparently no available name for the East Siberian animal, I have conferred upon it the name *orientalis*, in allusion to its extreme eastern distribution. Erxleben's *Erinaceus sibiricus* (Syst. Reg. Anim., 1777, p. 172) was based on Seba's figures and brief description of his "Erinaceus Sibiricus" (Thes. I, p. 79, pl. 49, figs. 4 and 5). Seba's figures are unidentifiable, and the only hint as to the locality of his specimen is the name, which he renders in French as "Herisson de Siberie." The diagnosis, "Coloris est obscure russi; . . ."; or, "Il est d'un roux foncé, . . ." obviously does not apply to the pale East Siberian species. The only other name to be considered is *amurensis* Radde, used in his description of Plate V (Reisen im Süden von Ost-Siberien, I, 1862, p. 325), where he says: "Fig. 1. *Erinaceus europœus L.* (*amurensis*) a. c. d." But nowhere in the text does he state the locality of the specimen figured, and throughout his text and tables of measurements mentions only skulls from Dauria, Sarepta, and St. Petersburg. In any case his

figures clearly relate to an animal very different from the Vladivostok form here named *E. orientalis*.

35. **Sorex buxtoni,** sp. nov.

BUXTON SHREW.

Type, No. 18655, ♀ ad., July 27, 1901, Gichiga, west coast of Okhotsk Sea, Siberia; N. G. Buxton, Jesup North Pacific Expedition.

Summer pelage.— Above, including sides, dull pale reddish brown; below pale fulvous gray; tail thinly haired, bicolor, dark brown above, below dull gray with a fulvous tinge; ears small, nearly concealed by the fur.

Winter pelage (May specimen).— Above dark reddish brown; sides and underparts silvery whitish gray; tail well clothed, with a distinct pencil at the tip, brown above, clear gray below, darker at the tip, both above and below.

Fall pelage (September and October specimens).— Above dark brown, much darker than in summer pelage; sides and ventral surface gray, more or less tinged on the sides with fulvous,—not pure silvery gray as in spring specimens.

Measurements.— Type: Total length, 106; tail vertebræ, 34; hind foot, 14 mm. Twenty adult males measure as follows: Total length, 100.3 (93–111); tail vertebræ, 34 (31–37); hind foot, 13.8 (12–15). Twenty adult females measure: Total length, 95.6 (90–111); tail vertebræ, 34 (30–38); hind foot, 13.9 (12–15). The average total length of 40 specimens is thus slightly less than 100 mm. Of the 40 specimens, only 8 exceed 100 mm. in total length, and only 8 fall below 95 mm. The skull of the type measures 17 mm. in total length and 8 mm. in greatest width.

This species is represented by 42 skins and skulls and 4 specimens in alcohol, all taken by Mr. Buxton in the vicinity of Gichiga. Both sexes are about equally represented, and also several seasonal phases of pelage. One specimen was taken in January, 1 in April, 7 in July, and the others, except 6 taken Sept. 24–Oct. 6, at intervals between August 25 and September 11. They are thus mostly in summer pelage, with the sides brown like the back. The single May specimen has the sides and underparts clear silvery white, in strong contrast with the dark brown back. In a few specimens taken in September and October the dorsal area is dark brown and the sides gray like the ventral surface, but the gray is dull

and slightly brownish and is confined in most specimens to the lower border of the sides. The greater part of the series is in summer pelage, in which the color of the dorsal area is pale brown, the sides are like the back, and the gray of the ventral surface is dull with a slight tinge of yellowish.

Sorex buxtoni belongs to the *S. araneus* group, but differs from the true *S. araneus* of Sweden and other parts of northern Europe in its much paler colors at all seasons, and smaller size. It more nearly resembles *Sorex pribilofensis* Merriam, from the Pribilof Islands, from which it is almost indistinguishable in coloration in some of its phases.

"Russian local name, *Mysh*, meaning mouse, as the people do not distinguish between the mice, voles, and shrews.

"Abundant in suitable localities all over the Gichiga and Anadyr sections of Siberia, and probably the rest of Northeast Siberia. At Gichiga they prefer the higher places on the tundra where it is moist, and where there is a growth of low hawthorn bushes, or other places where there are shrubs or an undergrowth, as along the banks of streams or of tundra pools. They are active during the entire year and often come into the houses during the winter. They gave me much annoyance during the summer by devouring the mice and voles that had been caught in my traps, and by springing my larger baited traps and escaping unharmed. They were easily caught in traps baited with fresh fish or meat. They are most active during August and September." — N. G. B.

American Affinities of Certain East Siberian Mammals.

The mammal fauna of East Siberia, so far as genera are concerned, consists of exclusively Holarctic types, represented, with one exception (*Moschus*), in both Arctic America and Arctic Eurasia, but by more or less differentiated forms on the two continental areas. Whether some of the more slightly differentiated forms are to be regarded as species or subspecies depends upon the point of view. The results of modern research, however, when based on ample material, demonstrate that what in earlier days were looked upon as

circumpolar species are resolvable into a number of well-marked forms, which occupy definite geographic areas, and are characterized by easily recognized differences. That there is, nevertheless, a close interrelationship between the forms of boreal mammals inhabiting the two continents is beyond question, — a relationship so intimate that it could only have been brought about by a former land bridge connecting the two areas, the existence of which in comparatively recent time, geologically speaking, is generally conceded, if not practically demonstrated.

It is thus probable that most of the more northern types of mammal life on the two continents are the slightly modified descendants of types which formerly had a continuous circumarctic distribution, which have become slowly differentiated, probably mainly since the disruption of the former land connection at Bering Straits. To this category belong the whole of the ursid, canid, felid, and mustelid series (excepting, of course, the mephitine phylum), and such genera as *Cervus*, *Rangifer*, *Paralces*, *Ovis*, and *Ovibos*, and possibly *Bison* among Ruminants, and *Sorex*, *Evotomys*, *Microtus*, *Dicrostonyx*, *Lemmus*, *Sciuropterus*, *Sciurus*, *Eutamias*, *Citellus*, *Arctomys*, *Lepus*, and *Ochotona* among the Insectivores and Rodents. These types are so wide-spread and so diversified on both continents that it is hard to suppose that any of them owe their presence in America to any very recent immigration from Asia, or the reverse. Possibly, however, *Cervus*, *Bison*, and *Eutamias* may have been direct contributions from one continent to the other, the former from Eurasia to America, and the two latter from America to Eurasia, judging by their present relative representation in the two areas.

But the cases especially in point in the present connection are the occurrence along the Siberian and Kamchatkan coasts of types distinctively American. These are a species of weasel (*Putorius pygmæus*) closely related to *Putorius rixosus* of arctic and subarctic America, and only remotely related to any Eurasiatic species; a spermophile (*Citellus buxtoni*) closely related to the *Citellus* (=*Spermophilus* auct.) *parryi* group of boreal America, but only remotely related to any

known Old World type; a shrew (*Sorex buxtoni*) much more nearly related to certain Alaskan forms than to any other; the Kamchatkan Bighorn (*Ovis nivicola*), which is so much more nearly related to the American type of *Ovis* than to any Asiatic species that it was formerly referred to it. The Kamchatkan-Siberian *Evotomys wosnessenskii* is also more nearly related to some of the Alaskan members of the genus than to any of its Old World congeners. *Microtus*, *Arctomys*, *Vulpes*, and apparently *Ursus*, afford nearly parallel cases.

There is thus evidence that eastern Siberia has derived some of its present mammalian life from boreal America, and doubtless within a comparatively recent period. The American origin of various early types that eventually attained circumpolar distribution, as the horse, camel, and rhinoceros phyla, etc., is now well established by palæontological evidence, but that the same is true of some forms of the existing mammalian fauna does not appear to have been heretofore recognized.

Article V. — DESCRIPTIONS OF NEW RODENTS FROM SOUTHERN PATAGONIA, WITH A NOTE ON THE GENUS EUNEOMYS COUES, AND AN ADDENDUM TO ARTICLE IV, ON SIBERIAN MAMMALS.

By J. A. Allen.

In preparing my report on the mammals collected by the Princeton University Expeditions to Patagonia, 1896–1899, under the direction of Mr. J. B. Hatcher, the following additional species [1] have been found which appear to be undescribed. A more detailed account of them, with illustrations, will appear later in the final report on the collection, now nearly ready for publication.

The genus *Ctenomys* is represented in southern Patagonia by at least five well-marked forms, three of which appear to be new. *Reithrodon* and *Euneomys* are each represented by several forms, three of which have not been previously recognized. In working out these species, represented by abundant material, it has been found that *Euneomys* is not very closely related to *Reithrodon*, and equally distinct from *Phyllotis*, when properly restricted.

Ctenomys robustus, sp. nov.

Type, No. 84194, U. S. Nat. Mus., ♂ ad., Rio Chico de Santa Cruz, near the Cordilleras, Feb. 20, 1897; O. A. Peterson.

Pelage soft, short, somewhat lustrous. Above deep yellowish brown, varied with blackish, the hairs being dark slaty plumbeous for the basal two thirds, with a subterminal band of dark rusty yellow, and a very short black tip, with longer blackish-tipped hairs sparsely intermixed; below deep brownish ochraceous; ears dusky brown, barely projecting above the fur; upper surface of fore and hind feet dingy yellowish gray; tail well clothed with fine soft hairs, forming a slight pencil at the tip, yellowish gray, dusky at the tip above.

Other specimens vary from the above in being a little lighter or a little darker, both above and below. Tail variable in color, often wholly without any dusky median line above or any dusky tip; gener-

[1] *Eligmodontia morgani*, based on specimens in the present collection, was described in 1901 (*Cf.* this Bulletin, Vol. XIV, p. 409).

ally there is a very narrow median dusky line, extending from the tip anteriorly for a part or the whole of the length of the tail; in a few specimens it is strongly developed, broadens and increases in blackness towards the tip, and in rare cases the whole tip is black, with a short black stripe on the lower surface on the apical fourth or third of the tail.

Young examples differ from the adults in the general tint being duller and the pelage less lustrous.

Measurements. — Type: Total length, 290; tail vertebræ, 73; hind foot, 40. Nine adult males measure as follows: Total length, 303.5 (290–322, only one above 310, and only two above 298); tail vertebræ, 81.5 (73–88); hind foot, 40.5 (40–42). Five adult females: Total length, 275 (256–300; only one above 280); tail vertebræ, 75 (70–80); hind foot, 37 (35–40).

Skull, type: Total length, 52.5; basal length, 47; zygomatic breadth, 30; interorbital breadth, 10; mastoid breadth, 29.5; length of nasals, 20; palatal length, 25; diastema, 16; upper molar series, 9.6; lower jaw, inner base of incisors to posterior border of condyle, 33; inner base of incisors to tip of angular process, 41; height at condyle, 16; lower molar series, 10.3; distance between condyles, 18; distance between tips of angular processes, 37. Ten adult male skulls: Total length, 53.6 (51–55); zygomatic breadth, 30.5 (29–33). Five adult female skulls: Total length, 48 (46–50); zygomatic breadth, 27.5 (26.2–28.6). The mastoid breadth is practically the same as the zygomatic breadth, varying in different specimens from slightly more to slightly less. The greater part of the skulls in the present series are middle-aged, with all the sutures distinct; only two or three give evidence of being very old.

Represented by 23 specimens, all from the upper Rio Chico, Cordilleras, and all collected by Mr. Peterson, February 7 to 28 (except one taken March 9). All but three are in adult pelage, and these have nearly acquired it, only the lower part of the back and rump retaining the pelage characteristic of immaturity. The general color above of the adults varies from strong yellowish brown to slightly rufescent brown, and below from deep ochraceous buff to brownish ochraceous. The color of the tail is very variable, as already noted; except in the case of a few which have the tail practically uniform yellowish gray, no two have the tail colored alike, in respect to the median dorsal line, which varies from a slight trace of dusky to a well-defined blackish median stripe, the black widening and increasing in intensity apically; in three speci-

mens the whole tip of the tail is black, including the under surface. A few other specimens approach this condition.

As shown by the measurements already given, the females are much smaller than the males.

The skull is very variable in respect to size and many details of structure, but especially in the size and form of the interparietal. In one specimen it is almost obsolete, forming a mere line less than a millimeter in antero-posterior extent and 5 mm. in transverse extent. Generally it is subtriangular, with a transverse width of 5–7 mm. and an antero-posterior length of 2–4 mm. It is sometimes divided medially into two halves. On each side of the interparietal, and separated from it by the posterior extension of the parietals, is an intercalated bone of variable size and of an irregularly oval outline, each generally considerably larger in area than the interparietal.

Ctenomys robustus differs markedly in coloration from *C. magellanicus*, but not very appreciably, so far as specimens of the latter are available for comparison, in size or in cranial characters. *C. magellanicus* is pale yellowish gray, or ash gray with a fulvous tinge, while *C. robustus* is dark yellowish brown. *C. boliviensis* is very much larger and very much darker and redder, having "the general hue bright rufous brown," and the upper surface of the nose, head, and nape blackish. It appears to have no close relationship to any of the other described species of *Ctenomys*.

Ctenomys sericeus, sp. nov.

Type, No. 84191, U. S. Nat. Mus., ♂ ad., Cordilleras, upper Rio Chico de Santa Cruz, Patagonia, Feb. 5, 1897; O. A. Peterson.

Type. — Pelage short, soft, and glossy. General color above yellowish gray strongly varied with black, the hairs being slaty plumbeous for the basal three fourths, then banded narrowly with pale yellowish brown, and tipped with black; flanks and ventral surface buff; sides of nose yellowish brown; top of nose and top of head like median dorsal region, which is darker than the sides; ears very small, blackish; upper surface of feet dingy gray with a slight yellowish cast; tail pale yellowish, with a median dusky stripe along the apical half of the upper surface.

In some specimens there is a tendency to a well-marked darker median dorsal band, extending from the nose to the base of the tail. Several of the specimens are a little darker than the type above described. The tail stripe varies in distinctness from nearly obsolete to a broad, well-defined black band running the whole length of the tail.

Young in first pelage are grayer and with less fulvous, and the pelage is longer, softer, and less firm.

Measurements. — Type: Total length, 208; tail vertebræ, 62; hind foot, 28. Five adult males: Total length, 200 (195–208); tail vertebræ, 56.6 (51–62); hind foot, 26.2 (25–28). A single adult female measures: Total length, 210; tail vertebræ, 60; hind foot, 27.

Skull, type: Total length, 39; basal length, 35.2; zygomatic breadth, 24; mastoid breadth, 23.5; interorbital breadth, 7; length of nasals, 13; palatal length, 17; diastema, 10; upper molar series, 7.5; lower jaw, inner base of incisors to end of angular process, 29.5; height at condyle, 7; width between condyles, 15.3; width between tips of angular processes, 25.6; lower molar series, 8. Four adult male skulls: Total length, 36.4 (34.3–39); zygomatic breadth, 21.5 (20–23.6). An old female skull measures, total length, 36; zygomatic breadth, 20.

In several of the skulls the interparietal is entirely absent, and when present is very small. The lateral intercalated bones are present, and are as variable in form as already described in *Ctenomys robustus.*

Represented by 11 specimens, collected by Mr. Peterson at the eastern edge of the Cordilleras of the upper Rio Chico de Santa Cruz, Jan. 31–Feb. 7, 1897. Six are adults and five are young, partly in juvenile pelage.

This species exceeds only a little in size *Ctenomys pundti* Nehring, but differs from it very markedly in coloration. The total length of the skull of *C. pundti* is given as 31.3, and the zygomatic breadth as 19.5; the same for *sericeus* (average specimens) being, respectively, 36 and 21.5. While it agrees practically in size with *Ctenomys bergi* Thomas, from the central part of the Province of Cordova, it differs greatly from it in color, being much darker throughout.

Ctenomys colburni, sp. nov.

Type, No. 147, Colburn Coll., ♂ ad., Arroyo Aike, in the basalt cañons, 50 miles southeast of Lake Buenos Ayres, Patagonia, April 19, 1898; A. E. Colburn, after whom the form is named.

Similar to *C. sericeus* but larger, much more strongly suffused with fulvous, and less varied with black.

Measurements. — Type: Total length, 230; tail vertebræ, 65; hind foot, 29. Fifteen males measure as follows: Total length, 224.5 (210–240, with one 245 and one 250); tail vertebræ, 69 (60–75, with two at 80); hind foot, 30 (28–32, and one 33). Seventeen females: Total length, 213 (200–225); tail vertebræ, 62.2 (60–65); hind foot, 29.5 (29–31).

Skull. — Type, total length, 43; basal length, 39; zygomatic breadth, 25; mastoid breadth, 25; interorbital breadth, 8.5; length of nasals, 14.3; palatal length, 20; diastema, 6; upper molar teeth, 8; lower jaw, inner base of incisors to posterior border of condyles, 28.5; inner base of incisors to point of angular process, 33.5; height at condyle, 8; width between condyles, 16; width between points of angular processes, 27; lower molar teeth, 8.5. Seven old male skulls measure: Total length, 43 (41–45); zygomatic breadth, 24.3 (23.5–25.3). Fifteen old female skulls: Total length, 38 (36–41); zygomatic breadth, 22.2 (21–24).

Represented by 33 specimens — 16 males and 17 females — all adult except 3, and all collected by Mr. Colburn, of which 16 were taken in the basalt cañons south of Lake Buenos Ayres, April 2 to May 15, and 17 near Swan Lake. Aside from the young specimens, which are grayer and much less fulvous than the adults, the variation in color consists in some specimens being a little more strongly suffused with yellowish than others, and in the distinctness of the tail stripe, which is often wholly wanting, or present in varying degrees, from a faint trace to a broad black stripe.

This species is intermediate in size between *C. sericeus* and *C. mendocina*, being larger than the former, and differing from it in its more strongly fulvous and generally lighter coloration, and from the latter in considerably smaller size and entire absence of any reddish suffusion.

Oxymycterus microtis, sp. nov.

Type, No. 84234, U. S. Nat. Mus., ♂ ad., Pacific slope of the Cordilleras, near the head of the Rio Chico de Santa Cruz, March 7, 1897; O. A. Peterson.

Adult male (type), March. — Pelage thick, short, and fine, almost mole-like in character. Pelage and general color almost exactly as in *Oxymycterus lanosus* Thomas, but twice the size of that species,

with the tail one half shorter and fore claws large, fossorial. Above dark yellowish brown; underparts whitish gray, the plumbeous under fur tinging the otherwise whitish surface; top and sides of nose dark grayish brown, without any tinge of yellow or rufous; ears very small, scarcely reaching the surface of the short fur, concolorous with the enclosing fur; tail very short, but little exceeding the length of the hind foot, very thickly clothed, dark brown, only slightly lighter below than above; upper surface of the feet grayish brown, the toes lighter, yellowish white; soles naked, dark flesh-color.

A second specimen is exactly similar in coloration, except that the ventral surface has a slight wash of buff, apparently due to staining.

Measurements. — Total length (type), 138; tail vertebræ, 28; hind foot, 21; longest fore claw, 6. *Skull*, total length, 27.6; basal length, 23.6; zygomatic breadth, 12.5; width of brain case, 12; interorbital breadth, 5; length of nasals, 10.5; palatal length, 10; palatal foramina, 5; diastema, 6.3; upper molar series, 3.5; length of lower jaw (inner base of incisors to posterior border of condyle), 15; height at condyle, 5.5; lower molar series, 3.4.

Represented by two specimens — a skin and skull, and a skin and skeleton — collected on the Pacific slope of the Cordilleras, at the head of the Rio Chico de Santa Cruz.

Externally *Oxymycterus microtis* is a miniature of *Akodon macronyx* with a relatively much shorter tail. It exactly resembles in coloration above and in the texture of the pelage *Oxymycterus lanosus*, but the latter has whiter under parts, is very much smaller, has a much longer tail, and small, nonfossorial claws; but the skulls of the two are very similar in general contour, differing only in size and slightly in details. *O. microtis* thus combines the large fossorial claws of the *Akodon macronyx* group with the cranial characters and weak dentition of the *O. lanosus* type. The narrow line separating *Akodon* and *Oxymycterus* is thus still further narrowed by the present annectent link.

Reithrodon cuniculoides obscurus, subsp. nov.

Type, No. 3, Colburn Coll., ♂ ad., Punta Arenas, Patagonia, Jan. 1, 1898; A. E. Colburn.

Similar to *Reithrodon cuniculoides*, but darker throughout, the upper parts dark brown, varied with black-tipped hairs and suffused with fulvous, the sides yellowish, and the ventral surface brownish ochraceous; inner side of thighs and anal region whitish; top of head

blackish, slightly varied with buff-tipped hairs; sides of nose and cheeks brownish ochraceous like the ventral surface; ears very thinly haired, brown externally, brownish buff internally, with a deep ochraceous buff post-auricular patch; upper surface of feet clear white; tail blackish above along median line, sides and below grayish white.

Measurements (of type, from dry skin). — Total length, 195; head and body, 130; tail, 65; hind foot, 34. (The tail seems to have lost a small portion of the tip.) Skull (imperfect), length of nasals, 15.5; palatal length, 18; palatal foramina, 10; diastema, 9.5; upper molar series, 6.

Unfortunately represented by only the type specimen, which has no flesh measurements. The skull shows the specimen to be fully adult, and larger than any skull in the large series of *R. cuniculoides*. It is characterized by its strong, dark coloration, between which and the darkest, most-deeply colored specimen in a series of 28 examples from the coast region and the interior plains, there is a striking contrast through the greater depth and intensity of all the tints. Considering the climatic conditions of the two regions,— the moist, forested country of the Punta Arenas district, and the open, arid plains of the coast and interior — the differences here shown in the coloration of the two phases conform to what would be expected to result from such diverse physical conditions. The differences are certainly not to be accounted for by season or age. It finds an exact parallel in the cases of *Akodon xanthorhinus* as compared with *A. canescens*, and *A. michaelseni* as compared with *A. macronyx*.

Reithrodon hatcheri, sp. nov.

Type, No. 84210, U. S. Nat. Mus., ♂ ad., Pacific slope of the Cordilleras, head of the Rio Chico de Santa Cruz, March 11, 1897; O. A. Peterson. Named in honor of Mr. J. B. Hatcher, Director of the Princeton Patagonia Expeditions.

Similar in size and proportions to *R. cuniculoides*, but much darker, and with much less fulvous suffusion.

Adult male (type), March. — Above dark grayish brown, varied with black-tipped hairs, faintly suffused with grayish fulvous; sides paler, passing gradually into the pale buff of the ventral surface; sides of nose, lower border of cheeks, lower border of flanks, and whole ventral surface cream-buff, except inside of thighs and adjoining portion of ventral surface; ears rather thinly haired, externally dull

brown, internally yellowish buff, the hairs at the anterior base of the ears whitish and the post-auricular patch pale buff; upper surface of the feet white; soles of hind feet to base of toes densely haired, dark brown, toes flesh-color; tail with a narrow brown stripe above, sides and below dull whitish.

Measurements. — Type: Total length, 230; tail vertebræ, 78; hind foot, 34. Seven specimens (4 males and 3 females) measure: Total length, 215 (200–230); tail vertebræ, 77 (75–82); hind foot, 33.3 (32–35). *Skull* (type).—Total length, 35.7; basal length, 31; zygomatic breadth, 20.5; interorbital breadth, 4; length of nasals, 16; palatal length, 17.5; palatal foramina, 9; diastema, 8.5; upper molar series, 6.4.

Represented by 10 specimens, all collected by Mr. Peterson in the Cordilleras at the head of the Rio Chico de Santa Cruz, and all but one (the type, taken March 11) between February 4 and 21, 1897. Part of the specimens, including the type, are in the dress of the breeding season, while others have partly or wholly acquired the post-breeding dress. These have a stronger suffusion of yellowish buff on the sides and ventral surface, but are otherwise similar to the type. A quarter grown young example is similar in general coloration to the adults, except that the ears have the external surface blackish and the internal surface deep buff, with the hairs at the anterior base of the ears and the post-auricular patch also deep buff, in prominent contrast with the surrounding pelage, as is not the case in the adults.

Reithrodon hatcheri is readily distinguishable from *R. cuniculoides* by its much darker and less fulvous coloration, the contrast in color between the two series being conspicuously noticeable. There are apparently no cranial differences of importance.

Euneomys petersoni, sp. nov.

Type, No. 84198, U. S. Nat. Mus., ♀ ad., upper Rio Chico de Santa Cruz, near the Cordilleras, Patagonia, Feb. 10, 1897; O. A. Peterson, for whom the species is named, in recognition of his important field work on the mammals of Patagonia.

Similar in coloration to *Phyllotis xanthopygus*, but very much smaller, with a relatively very short tail and naked soles, but the upper incisors are as strongly grooved as in *Reithrodon cuniculoides*.

Adult (type), February. — Pelage very long and soft, almost woolly. Above dark gray-brown, varied with blackish and fulvous, the pelage

being plumbeous black for the basal four fifths, with an apical band of brownish fulvous, and many longer black hairs intermixed; sides much paler and more fulvous, the fulvous increasing in intensity along the lower border; ventral surface soiled white, the fur being basally very dark plumbeous and broadly tipped with yellowish white; ears dark brown on both surfaces and very thinly haired, the surrounding fur concolorous with that of the anterior dorsal surface; sides of nose and lower border of cheeks whitish gray with a faint tinge of yellowish; soles naked except the posterior third, dark flesh-color; upper surface of fore and hind feet pale flesh-color, nearly white; tail one third or less than one third of the total length, well clothed, dusky brown above, sides and below white.

Measurements. — Total length, 175; tail vertebræ, 60; hind foot, 26. Three other specimens (young adults) measure: Total length 160 (150–165); tail vertebræ, 57 (50–60); hind foot, 25 (25–25).

Skull. — Long and narrow, the interorbital and rostral portions especially elongated; post-palatal fossa narrow and v-shaped, but not quite so narrow and pointed in front as in *Reithrodon cuniculoides;* front border of zygomatic plate as in *Phyllotis*, *Oryzomys*, etc., lacking the pointed superior process seen in *Reithrodon* and *Sigmodon;* bullæ small and pointed, as in *Phyllotis;* upper incisors deeply grooved; molars brachyodont as in *Phyllotis*, but very broad and heavy, — not hypsodont as in true *Reithrodon;* lower jaw short and heavy to support the thickened molars; posterior end of lower incisor encapsuled, forming a prominent process on the outer sides at the base of the condyloid process. Dimensions (type): Total length, 30.5; basal length, 26.5; zygomatic breadth, 17.5; interorbital breadth, 3.5; width of brain case, 14; length of nasals, 14; palatal length, 14.5; palatal foramina, 8; diastema, 8.5; upper molar series, 5.2; width of first molar, 1.8; lower jaw, length (inner base of incisors to posterior border of condyle), 18; height at condyle, 15; lower molar series, 5.5.

Represented by four specimens, an adult female that had suckled young, and three younger specimens, nearly adult, all taken by Mr. Peterson in the Cordilleras at the head of the Rio Chico de Santa Cruz, Feb. 8–14, 1897. These specimens are all quite similar in coloration, except that the younger ones are grayer than the adults, with much less fulvous suffusion and with very little fulvous on the flanks and ventral surface.

This species finds its nearest ally in *Euneomys chinchilloides* (Waterhouse), known thus far only from Tierra del Fuego, which it apparently closely resembles in size and coloration.

Note on the Genus *Euneomys* Coues.

Waterhouse, in founding the genus *Reithrodon* (P. Z. S., 1837, p. 29), included in it two species, *R. typicus* and *R. cuniculoides*, which appear to be strictly congeneric. In the 'Zoölogy of the Voyage of the Beagle' (Mammalia, Part II, 1839, p. 72), he added as a third species, *R. chinchilloides*, and gave figures of *R. cuniculoides* and *R. chinchilloides*, including the external characters and the skull and teeth of each, and the lower molar teeth of *R. typicus*. In 1874, Dr. Coues (Proc. Acad. Nat. Sci. Phila., 1874, p. 185), and later in 'Monographs of North American Rodentia' (1877, pp. 118, 119), from a study of Waterhouse's figures, divided the genus *Reithrodon* into two groups, to which he gave the rank of subgenera, making *R. cuniculoides* the type of the restricted group *Reithrodon*, and *R. chinchilloides* the type and only species of his "subgenus" *Euneomys*, giving very clearly some of the principal differential characters of the two groups. The more important of these are: (1) "Anterior root of zygoma deeply emarginated in front" in *Reithrodon* and "about straight in front" in *Euneomys;* (2) "palate ending much behind the molar series, and showing a median ridge intervening between lateral paired deep excavations" in *Reithrodon*, and "palate ending nearly opposite the last molars, slightly ridged or excavated" in *Euneomys;* (3) "pterygoid fossæ deeply excavated, and the bones very closely approximated" in *Reithrodon*, and "pterygoid fossæ shallow and these bones less approximate" in *Euneomys;* (4) "condyloid process of lower jaw concave internally" in *Reithrodon*, and "condyloid process of the lower jaw flat internally" in *Euneomys;* (5) "coronoid process slender, very oblique" in *Reithrodon*, and "coronoid process very broad, nearly vertical" in *Euneomys*. To these may be added (6) the very different enamel pattern of the molar teeth in the two groups, in *Reithrodon* the folds being transverse with the outer and inner loops alternating, and in *Euneomys* oblique, with one less fold in each of the last two upper teeth, and in the first two lower teeth, — a very radical difference in tooth structure, which alone warrants the generic separa-

tion of the two groups. As Waterhouse figured the crown surface of the teeth in only *R. cuniculoides*, this most important difference of all necessarily escaped Coues's attention.

In both these genera — *Reithrodon* and *Euneomys* — the tooth structure is remarkably distinctive for genera of Muridæ, and, as compared with each other, presents almost the extremes of unlikeness. But a further noteworthy difference (7) is seen in a pair of depressions on the posterior third of the palatal surface in *Euneomys*, which are absent in *Reithrodon* and in all of the allied genera.

A comparison of *Euneomys* with "*Reithrodon*" *pictus* shows that there is only the superficial and purely incidental resemblance of the grooved upper incisors, which, however, are only slightly sulcate in *R. pictus*, *Phyllotis bolivianus*, and their allies, and deeply sulcate in *Euneomys*. In all essential respects *Reithrodon pictus* is a *Phyllotis*, but sufficiently aberrant, perhaps, to warrant its subgeneric separation; but its relationship appears not to be with *Euneomys*, as has been assumed (*cf.* Thomas, Ann. and Mag. Nat. Hist. (7), VIII, 1901, p. 254).

ADDENDUM TO ARTICLE IV, ON SIBERIAN MAMMALS.

At the time of preparing my report on the mammals collected in northeastern Siberia by the Jesup North Pacific Expedition, a series of 9 Arctic Foxes (*Vulpes lagopus*) in summer coat, purchased by Mr. W. Bogoras at Mariinski Post (mouth of Anadyr River), had been mislaid and were overlooked. They have since been found and seem worthy of record.

These specimens show that the summer coat presents two phases, a light and a dark phase. Four of the specimens represent the dark phase, three the light phase, two are intermediate (one approaching the light phase and one nearer the dark phase), and one, the most interesting of all, in moult, showing the process of change from winter to summer dress. *Dark phase:* Whole dorsal area dark, almost blackish brown, passing into light yellowish brown on the flanks, and still lighter yellowish brown on the ventral surface. This is the color of the longer overhair; the woolly underfur is dark grayish brown over

the median dorsal area, lighter or gray on the sides, and light gray on the ventral area. *Light phase:* Whole dorsal area with the longer hairs grayish brown, sides and ventral surface lighter, with the under-fur light gray or grayish white. The general effect over the dorsal area is dark gray, instead of dark brown as in the dark phase. The specimen in moult has the whole head, limbs, and posterior third of the back dark seal brown, and the pelage very short; the rest of the body is still in the long pure white winter coat, but on parting the dense winter pelage a blanket of short brown fur and hair is found sprouting beneath the winter coat, these short brown hairs being longest and most abundant near the junction of the areas covered respectively by the summer and winter coats.

I also take this opportunity to correct an error in my account of the Kamchatka Bighorn (*antea*, p. 130). Since the distribution of my paper on Siberian Mammals Mr. Lydekker has called my attention to his paper, 'The Wild Sheep of the Upper Ili and Yana Valleys,' (P. Z. S., 1902, pp. 80–85, pll. vii and viii), which I (most inexcusably) overlooked in writing of the Kamchatka Bighorn. Apparently my specimens are referable to *Ovis borealis* Severtzoff, since they agree with Mr. Lydekker's description and colored figure of this species (*l. c.*), alt hough its type loclity is about a thousand miles to the westward of the Taiganose Peninsula, where my specimens were collected. I called attention to the differences in coloration between my specimens and the description and figure of *O. nivicola* as given by Lydekker in 'Wild Oxen, Sheep, and Goats of All Lands,' and deeming it improbable that two species of sheep would be found so near each other as the Taiganose Peninsula and the points in the neighboring parts of Kamchatka where *O. nivicola* is known to occur (indeed, Lydekker, in the work last cited, p. 224, gives the range of *O. nivicola* as "typically the countries forming the northern shores of the Sea of Okhotsk, namely the peninsula of Kamschatka on the east and the Stanovoi Mountains on the west," etc., thus including the Taiganose Peninsula), I ventured to criticise the coloring of the head given in Lydekker's figure. It now appears that the criticism was unwarranted, and that there are two species of *Ovis* living about the head of the Okhotsk Sea. For the present, therefore, I am content to refer my Taiganose specimens to *O. borealis* rather than to *O. nivicola*, with some suspicion, however, that they will not prove subspecifically the same as the *O. borealis* of the Yana River regoin, nearly one thousand miles to the northwestward of the Okhotsk Sea. I certainly do not agree with Mr. Lydekker in referring any of Siberian sheep to *Ovis canadensis* of North America, even as subspecies.

Article VI. — THE FAUNA OF THE TITANOTHERIUM BEDS AT PIPESTONE SPRINGS, MONTANA.

By W. D. Matthew.

The American Museum Expedition of 1902 in western Montana had for object to make a further search in the Tertiary deposits of that region, where Mr. Earl Douglas has recently discovered many new and interesting fossil mammals. In the White River formation near Pipestone Springs, Mr. Douglas had found a very interesting micro-fauna, and our collections at the same locality, which Professor Osborn has kindly turned over to me for study and description, enable us considerably to extend the list. I am indebted to Mr. Douglas for the opportunity to examine the type specimens of his various species, as well as for the information concerning localities, etc., contained in the stratigraphic part of his very excellent memoir recently published on the White River of Montana.

The majority of the species are small or minute forms, not found in the Titanotherium Beds of South Dakota or Colorado, where the scanty fauna is almost entirely of large animals, — Titanotheres, Elotheres, and Rhinoceroses. A few small species have been described from Swift Current Creek, Canada, based on very fragmentary materials. The Pipestone Springs fauna is therefore of much interest, as it illustrates the direct precursors of the numerous small species of the Oreodon Beds. In the species from the three successive stages of the White River we have the most favorable opportunities for study of the details of evolutionary progress in a given race that are presented among fossil vertebrata; for the materials are abundant and complete, the succession is unquestionable, and the character of the beds, and hence the local conditions of deposition, very uniform, so that we get the same facies of the three faunas. It is doubtful how far, if at all, the Eocene deposits of the Rocky Mountain divide and foothills contain the same facies of their respective

faunas as do the Oligocene deposits of the plains. They contain an important aquatic contingent, fish, crocodiles, and water-turtles being comparatively abundant. In the White River fauna all these are absent, except in the sandstone lenses,[1] while a large element of it is apparently adapted to open grassy plains; this is not found in the Eocene faunas. But in the three zones of the White River a great part of their respective faunas appears to be in direct and exact genetic succession. We can therefore measure the amount and direction of change during the Oligocene epoch in many series.

The amount of evolution as thus measured appears small, but its direction somewhat constant. The species of the Titanotherium Beds are all distinct from their successors in the Oreodon Beds, but the difference is uniformly small. Between the Oreodon and Leptauchenia faunas the difference is often greater but less uniform, so far as present data go. Some genera run through the three horizons (*e. g.*, *Cynodictis*, *Palæolagus*, *Mesohippus*, *Cænopus*, *Leptomeryx*). Others have been found only in the two lower zones or in the two upper zones, while many are as yet known from one horizon only.

Stratigraphy. — Mr. Douglas refers all the Tertiary at this locality to one stage, correlating it with the Titanotherium Beds of South Dakota. We find, however, a lithologic distinction between the higher beds exposed north of the railroad, which resemble the Oreodon Beds of South Dakota, Colorado, and elsewhere, and the lower beds exposed south of the railroad, which resemble rather the Titanotherium Beds of some parts of South Dakota. Likewise on Thompson's Creek, not far from the Pipestone locality, we were able to distinguish between the Oreodon Beds exposed near the head of a small northerly branch of the creek, and the Titanotherium Beds exposed on the main western branch. At

[1] Mr. Douglas has recently discovered fish remains in strata which he refers to the White River *epoch*, so-called, in the Madison valley in Montana. But these strata are quite different in character from the beds in which White River mammals are found, apparently lacustrine or fluviatile in origin, and a very thorough search on his part failed to reveal any mammals in them except a skull of the beaver *Steneofiber*. I do not understand that he considers them as of the same formation or origin as the mammal beds, but merely as of equal age. The discovery of fish in them, therefore, does not at all invalidate the fluviatile-eolian hypothesis of origin of the White River formation maintained by Hatcher and myself. The same explanation probably applies to other reported occurrences of fish in the White River.

both localities the lithologic distinctions are confirmed by the fossils found.

The Titanotherium Beds are soft, easily weathering, banded clays, often sandy, crumbling to the usual weathered-clay surface, varying in color from dark reddish brown through buff to an almost greenish white. Cross-bedding is seen in the sandier layers. They are not unlike the Titanotherium Beds in South Dakota, but run to deeper and more contrasted coloring. At Pipestone Springs they dip quite steeply toward the north, lying up against the ancient crystalline rocks on the south side of the creek. We found in them the following fauna:

Marsupialia.

Peratherium titanelix, sp. nov.	Allied to *Peratheria* of Middle Eocene and Oligocene.

Insectivora.

Apternodus mediævus, g. et sp. nov.	Allied to ? *Centracodon* of Middle Eocene.
Micropternodus borealis, " "	Allied to ? *Centetodon* of Middle Eocene.
Ictops acutidens *Douglas* " thomsoni, sp. nov.	More primitive than any Middle Oligocene Leptictid.

Creodonta.

Pseudopterodon minutus (*Douglas*) ? Hyænodon sp.	Intermediate between the Oligocene *Hyænodon* and Middle Eocene *Sinopa*.

Carnivora Fissipedia.

Bunælurus infelix, sp nov.	
Cynodictis paterculus, sp. nov.	Somewhat more primitive than Middle Oligocene species.

Rodentia.

Ischyromys veterior, sp. nov.	Somewhat more primitive than Middle Oligocene species.
Cylindrodon fontis *Douglas*.	
Sciurus vetustus, sp. nov.	
Gymnoptychus minor (*Douglas*).	
" minimus, sp. nov.	

Palæolagus temnodon *Douglas.* " brachyodon, sp. nov.	More primitive than Middle Oligocene species.

Perissodactyla.

Mesohippus westoni *Cope.*	More primitive than Middle Oligocene species.
Hyracodon sp.	
? Cænopus sp.	
Titanotherium sp.	

Artiodactyla.

Stibarus montanus sp. nov.	
Bathygenys alpha *Douglas.*	
Limnenetes sp. div.	
Leptomeryx mammifer *Cope.*	
" ? esulcatus *Cope.*	
Leptotragulus profectus sp. nov.	Advanced species of an Eocene genus.

Lizards and Tortoises, sp. div.

Two species are reported by Mr. Douglas of which we obtained no further evidence: *Sciurus jeffersoni* Douglas, ? *Agriochœrus maximus* Douglas.

The Oreodon Beds are buff clays, somewhat harder than the Titanotherium Beds, finer, not sandy, more calcareous, and not unlike the Oreodon Beds of Dakota and Colorado. They were very barren so far as we could discover, and the only determinable fossils found at Pipestone Springs were: *Palæolagus haydeni*, *Eumys elegans*, *Mesohippus bairdii*, ? *Poëbrotherium.*

These are all characteristic species of the Oreodon Beds in South Dakota, Colorado, etc.

The fauna from the Titanotherium Beds is a quite remarkable one. Not a single species is identical with those of the Oreodon horizon; all are either new, or have been described by Douglas from the same locality, or by Cope from the same horizon at Swift Current Creek. The majority of the species, however, belong to genera of the Oreodon Beds, and these, though fairly distinct, are not widely divergent from their successors. We find that the Pipestone Beds are much nearer to the Oreodon horizon than to the upper Uinta or Diplacodon Beds. Fourteen genera are in common with the

later horizon, while there is but one Uinta genus (*Leptotragulus*) and that represented by a rather divergent species. This contrast is partly explained by the fact that the known White River fauna is a very large one, while that from the Uinta is comparatively small; partly also by considerations of geographical distribution of the Oligocene mammals and by different conditions of deposition in the Uinta and White River beds. But, making allowance for all these, there seems still to be a considerable gap between the Diplacodon and Titanotherium faunas, while the latter is much closer to the Oreodon fauna. It shows some marked differences, however:

(1) There are two new insectivore genera of the primitive section (Zalambdodonta) of the order, which has hitherto been practically unknown in a fossil state, unless the Eocene species reported by Professor Marsh shall prove to belong to it.

(2) All the rodents are sciuromorphs[1] or lagomorphs. Myomorpha, more abundant than sciuromorpha in the Oreodon Beds, have not yet appeared. They are unknown in the Eocene, except *Protoptychus*, a form of doubtful affinities.

(3) The only Creodont from the Oreodon Beds is the highly specialized *Hyænodon*. At Pipestone Creek we have a more primitive type, intermediate between *Hyænodon* and *Sinopa*. At Swift Current Creek occurs *Hemipsalodon* (?=*Pterodon*), also less specialized than *Hyænodon*. (*Hyænodon* itself occurs also in the Titanotherium Beds.)

(4) *Oreodon* is not found, and two or three more primitive genera (*Bathygenys*, *Limnenetes*, ? *Agriochœrus*) take its place.

(5) *Hypertragulus*, common in the Middle and Upper Oligocene, is not found, while *Leptomeryx* of the Lower and Middle Oligocene is abundant and large.

(6) In place of *Poëbrotherium*, the camel of the Oreodon Beds, is found a brachyodont form, apparently the Eocene genus *Leptotragulus*.

From the above facts we would infer that the Pipestone Beds are at the base of the Oligocene, but above the Eocene, accepting Osborn's correlation of the White River formation

[1] If *Gymnoptychus* be considered a sciuromorph, as it was by Professor Cope and is by Dr. Hay.

with the Oligocene, and of the Uinta with the Upper Eocene. They are probably of approximately the same age as the White River beds of Swift Current Creek, Canada, with which they have three species in common, probably a fourth ("*Palæolagus turgidus*" from Swift Current Creek probably is *P. brachyodon*),— a fair proportion out of so limited a fauna.

Descriptions of Species.

MARSUPIALIA.

Peratherium titanelix, spec. nov.

Type, No. 9603, a lower law with p_3 and m_{2-4} and alveoli of the remaining teeth except incisors.

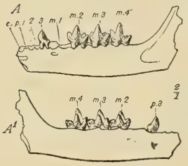


Fig. 1. *Peratherium titanelix.* Type specimen, twice natural size. *A*, outer, *A*[1], inner view of teeth.

This species is about the size of *P. huntii* of the Oreodon Beds, and resembles it in the rather short premolar region, the premolars and canine small, close together without any diastemata.

The molars are similar to those of typical *Peratheria* from the Phosphorites, but the premolars are very distinct, crowded, and reduced antero-posteriorly, the cusps recurved instead of symmetrical as in *Peratheria* from the Phosphorites, and in *P. fugax* of Cope. The anterior part of the jaw is rather short and deep and the canine directed more upward than in *P. fugax*.

Measurements.

Length p_1–m_4	7.3 mm.
Length m_{2-4}	4.2
Depth jaw under m_2	1.9

INSECTIVORA.

Apternodus mediævus, gen. et spec. nov.

Type, No. 9601, posterior half of a lower jaw with two complete molars and the root of another.

Molars composed of high trigonid and minute basal talonid. Protoconid high, sharp, and triangular, paraconid and metaconid subordinate. Dentition probably $i_?\ c_1\ p_3\ m_3$.

Talonid a small sharp cusp on m_3; on m_2 it is a minute postero-internal basal cusplet. The third molar a little smaller than the second; both are two-rooted, the anterior root wider transversely.

The cusps are all high, sharp, trigonal in cross-section, the whole tooth subtriangular with transverse and longitudinal diameters about equal and vertical diameter considerably exceeding either. The heel is much smaller than in Centetidæ, the protoconid higher and larger in proportion than in any other Insectivore or Chiropter.

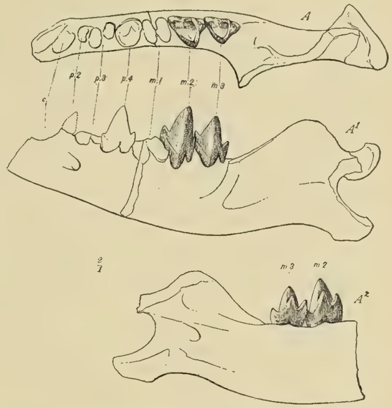


Fig. 2. *Apternodus mediævus.* Type, No. 9601, twice natural size, the outlines of front of jaw from No. 9607. *A*, crown; *A*[1], external, *A*[2], internal view.

No. 9608, a lower jaw without teeth, broken off in front at about the same point as the types, but with the condyle complete, appears to belong to the same species. The condyle is widely expanded transversely, on a level with the bases of the molars. The angle in the type specimen is extended into a rather long and stout flattened process with a sharp medial ridge on the internal side. The coronoid is broken off in both specimens, but was evidently high, stout, placed mostly external to the toothrow, and directed upwards instead of backwards.

No. 9607, the anterior part of a lower jaw, with one premolar preserved and the roots of other teeth, is provisionally referred to this species. The premolar is either the third or fourth; it is stout, two-rooted, composed of a round-conical protocone and small postero-internal basal cusp. The anterior root is wider than the posterior. The premolar in front of this was apparently similar but smaller, and was preceded by a small one-rooted premolar, and this by a larger tooth, probably a canine. Behind the premolar are roots of two teeth, one of which was probably m_1, the other certainly a molar, judging from comparison of the corresponding parts of the jaw in the three specimens.

The dentition is then probably $c_1\ p_3\ m_3$, but may be $c_1\ p_4\ m_3$. The weight of the anterior part of the jaw and doubtful

indications of a large alveolus lead to the suspicion that one or more of the incisors was enlarged.

No. 9612, part of a lower jaw with the roots of the last two molars, is also referred here.

This remarkable little jaw is quite unlike any described species of Insectivore or Chiropter, except, perhaps, Marsh's *Centracodon.* So far as anything can be determined from his brief description, the last molar of *Centracodon* is like the second molar of *Apternodus. Centracodon* has four premolars. Although the short, deep jaw would appear to ally it rather with the Chiroptera, yet as the tooth without talonid is quite unknown in this order, while it does characterize a section of the Insectivora, I leave it provisionally in the latter group, without attempting to assign it to any especial family. Its nearest relatives are most probably the little Eocene Insectivora from the Bridger Basin, described by Professor Marsh in 1872. With the probable exception of these Eocene types and of a single South American species, no fossil Insectivores of the Zalambdodont division have hitherto been described, although according to the Tritubercular theory this, as the more primitive section, should have been more abundant in ancient times.

Measurements.

M_{2-3}	3.9 mm.
M_2 longit.	2.0
" transv.	2.0
" height.	3.7
M_3 longit.	2.0
" transv.	1.8
" height.	2.9
Depth of jaw.	3.5

Micropternodus borealis, gen. et spec. nov.

Type, No. 9602, a lower jaw with p_3–m_3 and alveoli of the anterior teeth.

Dentition $\overline{3.1.3.3}$. Molars somewhat like those of *Centetes* in composition, with high trigonid and small, low talonid. Trigonid very wide transversely with pr^d considerably overtopping pa^d and me^d. Talonid with sharp posterior margin and low median ridge. Molars and especially premolars, short, high, and recurved; p_4 sub-molariform, with

small anterior and internal trigonid cusps and strong basal heel. P_3 much smaller and simpler, with small heel and no other accessory cusps. P_2 is small and one-rooted, canine small, incisors small, subequal. No diastemata except a slight one behind p_2. Jaw rather deep in front. Second molar slightly larger than the first, third much smaller.

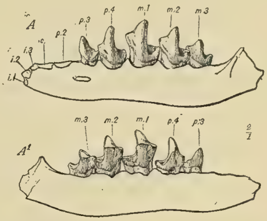


Fig. 3. *Micropternodus borealis.* Type specimen, twice natural size. *A*, outer, *A* [1], inner view of teeth.

Like the preceding genus, this must be placed among the Zalambdodonta, with no very near relatives among living species, although it is not so strikingly different from modern types. Its nearest allies are also quite probably some of the very inadequately described Insectivora from the Bridger Basin, but neither it nor *Apternodus* can be considered as possibly congeneric with any of the Bridger species, if Marsh's descriptions are correct.

Measurements.

Lower jaw, m_3 to incisive alveoli	12.4 mm.
Lower teeth p_3–m_3	8.4
Lower molars m_{1-3}	6.4
Lower molar, m_1 longitudinal, at base	1.8
" " " transverse	1.9
" " " height of crown	2.7

Ictops acutidens *Douglas.*

A fragmentary skull and jaws, with some limb-bones of one individual, and the upper and lower molars of another, confirm and extend the characters of this species as indicated by Douglas.

The distinctions from previously described species are:

Dimensions fifteen per cent. less than any of the Leptictidæ from the Oreodon Beds. First upper premolar one-rooted, two-rooted in *I. dakotensis* and *bullatus* and in *Leptictis haydeni.* Supra-temporal crests widely separated anteriorly and convergent posteriorly, instead of close together and parallel as in all the later species. Upper molars and p^4 more

constricted between the inner and outer cusps than in any described Leptictid; cusps somewhat higher and last molar less reduced than in any later species.

No. 9604, a fragmentary skull and jaw, with humerus, radius, two phalanges, and a caudal vertebra, exhibits most of the permanent dentition well preserved.

Upper jaw. — Incisors not known. Canine of moderate size, compressed, somewhat ridged externally, with no indication of the incipient heel seen in *Palæictops*. P^1 one-rooted, smaller than canine. P^2 two-rooted, compressed, with small posterior basal cusp or heel. P^3 three-rooted, with strong, well-separated *de*, higher but less separated *tr*, and minute antero-external basal cusp; the protocone much overtopping the other cusps. P^4 molariform, but *tr* not yet as high as *pr*, *de* equalling *pr* in height, small *hy*, and strong protostyle. First and second molars with *pa* and *me* of equal size, *hy* better developed than in p^4, a small protostyle on m^1. M^3 with reduced *me* and rudimentary *hy*. All molars and p^4 wide transversely, with some constriction between inner and outer cusps. M^3 smaller than m^1 and m^2, but not so much reduced as in the later species.

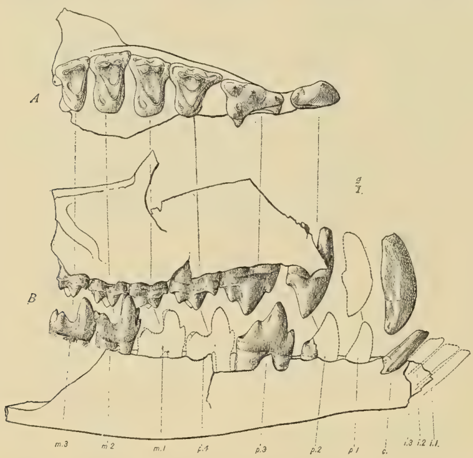


Fig. 4. *Ictops acutidens*. Teeth, twice natural size. *A*, crown view of upper teeth; *B*, external view of upper and lower teeth. No. 9604, the lower molars from No. 9605.

Lower jaw. — Dental series continuous without diastemata. Three small incisors. Canine small, incisiform, somewhat larger than incisors. P_1 one-rooted, p_2 two-rooted, p_3 two-rooted, compressed, with anterior and posterior cusps and small heel. The lower molars are not preserved in this specimen. In No. 9605 m_2 and m_3 are preserved; the trigonid is high, composed of two equal well-separated cusps, talonid much lower, bearing three posterior cusps, external, internal, and postero-median respectively, well separated from the trigonid but not from each other. M_3 is a little longer than m_2 but

much narrower, especially the talonid, in which the hypoconulid is situated more behind the hypo- and entoconid instead of nearly between them.

The skull is wider between the eyes than those from the Oreodon Beds, the postorbital constriction less pronounced. The temporal crests begin on the posterior third of the frontal bones, eleven millimeters apart, and converge rapidly on the posterior half of the parietals.

The humerus is disproportionately smaller and more curved than in *I. dakotensis*, the deltoid crest is not so wide nor does it extend so far down. The radius is likewise strongly curved, its distal end bearing two ill-separated subquadrate facets for scaphoid and lunar, the scaphoid facet the wider of the two. Two rather long and slender phalanges are preserved, one somewhat compressed laterally. The caudal vertebra associated is from the middle part of the series and indicates a large, long tail.

This species is in some, but not in all respects intermediate between *Palæictops* and the Leptictidæ of the Oreodon Beds. The last molar is more reduced than in *P. bicuspis*, less than in any later Leptictid. The first premolar is one-rooted, as in *P. bicuspis*, while in the later species it is two-rooted. On the other hand, the molars are more compressed and more constricted medially, and the size is smaller than in either the Wind River species or those from the Oreodon Beds; and the temporal crests are further apart than in the later species, while in the earlier one they are united into a sagittal crest.

Ictops thomsoni, spec. nov.

Two upper jaws, Type, No. 9606, Cotype, No. 9606*a*, indicate a species closely allied to *Ictops acutidens*, but distinguished by smaller size, more compressed teeth, and other characters of less importance. The metacone on all the molars is decidedly smaller than the paracone; in *I. acutidens* they are nearly, and in other Leptictidæ quite, equal in size on m^{1-2}. The protocone on p^4–m^3 is more

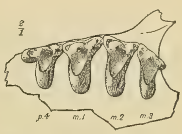


Fig. 5. *Ictops thomsoni.* Crown view of upper molars, × $\frac{2}{1}$. Type specimen.

compressed antero-posteriorly, and the constriction between it and the outer cusps is more marked than in *I. acutidens*. The hypocone is smaller on m^1 and m^2, absent on m^3 and p^4. The trittocone of p^4 is smaller than in *I. acutidens*.

All these distinctions are exaggerations of the differences between *I. acutidens* and the Leptictidæ of the Oreodon Beds, but none of them ally it to *Palæictops*, in which the molars and premolars (except p^1) are fully as complicated as in the species of the Oreodon horizon.

The species is named in honor of Mr. Albert Thomson of the American Museum Expedition of 1902, who discovered the type specimens of this as well as those of four other new species described in this article.

Comparative Measurements.

	I. thomsoni Type.	I. acutidens Nos. 9604 and 9605.	I. dakotensis Type.[1]	I. bullatus Type.	Mesodectes. No. 9316.	Leptictis Type.[1]
Upper molar-premolar series		20.8		23.5		24.
" true molars and fourth premolar	9.3	10.4		11.7	11.7	12.
" m^1 longitudinal	2.7	2.6	3.3	3.4	3.4	3.
" " transverse	3.9	4.0	4.0	5.3	4.9	4.7
" m^3 longitudinal	1.5	2.1		1.6	1.9	2.4
" " transverse	3.6	3.5		3.2	3.9	4.9
Lower molar-premolar series		E. 20.0				
" true molars		E. 10.1				
" m_2 longitudinal		2.7				
" " transverse		2.1				
" " height		3.7				

[1] Measurements from Leidy's figure.

CREODONTA.

? **Pseudopterodon minutus** (*Douglas*).

Hyænodon minutus Douglas.

No. 9623, the upper jaw of a small Creodont of the family Hyænodontidæ is referred provisionally to Schlosser's genus, and may be identified specifically with the lower molar on which Mr. Douglas based his species "*Hyænodon*" *minutus*. This upper jaw, however, cannot be referred to *Hyænodon*, as

the first molar shows a sharp antero-internal angle and small antero-internal cusp. It is not very close to Schlosser's type, and if, as Scott believes, *Pseudopterodon* is founded on milk teeth of *Hyænodon*, then our species represents an undescribed genus, which may well stand ancestral to *Hyænodon*, being directly intermediate between that genus and *Sinopa*.

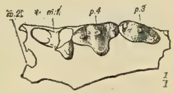


Fig. 6. *Pseudopterodon minutus*. Crown view of upper teeth, natural size. No. 9623.

The animal was a little smaller than *Cynohyænodon cayluxi* Filhol. P3 is two-rooted, slightly compressed, set a little transversely in the jaw, moderately high, with small anterior basal cusp and heel. P4 is three-rooted, the internal root well separated, median, supporting a strong internal buttress to the protocone and a basal cingulum, but no defined cusp. The antero-external cusp is of moderate size, the postero-external developed into a short cutting blade. M^1 is three-rooted, the inner root anterior and well separated, bearing a wide buttress ridge and a small internal cusp, which is worn off in the specimen. Only the front part of the tooth is preserved. M^2 was larger than m^1 and similar to it, judging from the character and position of the two anterior alveoli which indicate it on the specimen.

? *Hyænodont*, indet.

An upper premolar of singular character which I am unable to refer to any described species of Carnivore or Creodont. It has two roots, the posterior one broadened inwardly so as to support a median internal buttress to the protocone. The protocone is very high, its height exceeding the antero-posterior length of the tooth; somewhat compressed posteriorly, with a well-distinguished posterior cusp and small posterior cingular cusp. Cingulum obsolete except at anterior and posterior ends of tooth. Appears to be the third or, perhaps, second upper premolar of some Hyænodont, but not of *Hyænodon* or *Pterodon*.

CARNIVORA (Fissipedia).

Cynodictis paterculus, spec. nov.

Two lower jaws and parts of others, Nos. 9616, 9619, repre-

sent this species. Of these I take No. 9616 as type. Compared with a quite large series of specimens, including the types of *C. gregarius* and *C. lippincottianus*, these specimens show certain constant differences, chiefly in the construction of m_2. This tooth is proportionately larger and longer, the heel larger and wider, and the proto- and metaconids are raised above the paraconid, instead of being nearly on a level with it, as they usually are in *C. gregarius*. The shear of m_1 is somewhat more transverse, and m_3 is a little less reduced. The size is that of *C. gregarius*.

The above characters are slight distinctions indeed, but their constancy in the very considerable series of specimens compared makes them valid specifically. In *Procynodictis vulpiceps* of the Uinta, the shear is more transverse, but m_2 is smaller and its heel more reduced than in *C. gregarius*.

Measurements.

	Type, No. 9616	Cotype, No. 9618
P_1–m_3		35 mm.
M_1–m_3	18 mm.	17
M_1 longit	9.5	9.
" transverse	4.5	4.2
" height of pr_d	7.	
M_2 longit	5.5	5.2
" transv	3.5	3.3
M_3 longit	3.	..
" transv	2.5	..

Bunælurus infelix, spec. nov.

No. 9620, part of a lower jaw with p_4–m_1 and the stump of m_2, represent this species, which is with difficulty distinguishable from *B. lagophagus*. The protocone of m_1 is more rounded, the shear a little more transverse than in Cope's species. The fourth premolar appears to be stockier and longer than in the type of *B. lagophagus*, but it is not fully formed in the jaw in that specimen, so the comparison is questionable; the protocone is stout and round, with a small

postero-external cusp, and external basal cingulum rising to a small heel behind. The second molar is a minute crownless stump.

Measurements.

P_4–m_2	10.2 mm.
P_4 longit	4.1
" transv	1.9
M_1 longit	5.9
" transv	2.3
Depth of jaw beneath m_1	6.

A larger Musteline is indicated by part of a jaw, No. 9621, with p_4 and the roots of the front teeth in it. It is about the size of *Cynodictis paterculus*, but the premolars are higher, shorter; the heel smaller, anterior basal cusp absent; and other details join to show that it is a Musteline.

RODENTIA.

ISCHYROMYIDÆ.

Ischyromys veterior, spec. nov.

The anterior part of a skull and some forty jaws or parts of jaws, upper and lower, represent this species. It is considerably smaller than a series of specimens from South Dakota, which agree well with Leidy's types of *I. typus*, and the teeth are narrower throughout with higher cusps. It is much closer to the variety or separate species from Colorado, *I. cristatus* (Cope, 1872), which Cope has referred to *I. typus* and described and figured in 'Tertiary Vertebrata.' From this species I find a constant distinction in the last molar, which in the Montana jaws has always a narrow heel with the last crest imperfect internally, while in all the Colorado specimens the heel is as wide as the rest of the tooth, and the third (last) crest perfectly developed.

In the upper teeth a corresponding difference is to be seen in the last molar, and also the valley between the anterior and posterior inner cusps is well marked on all the teeth, distinct nearly to the base of the enamel, while in the specimens

from Colorado and from South Dakota it is obsolete on p4 and on the molars does not extend so far down.

? CASTORIDÆ.

Cylindrodon fontis *Douglas.*

We have eight lower jaws and an upper jaw of this species, some of which exhibit the tooth pattern, and enable us to refer this curious little rodent provisionally to the Beavers. The two lower jaws on which the species was based were of comparatively old individuals, and the pattern had disappeared, so that it was not possible for Mr. Douglas to determine its relationship.

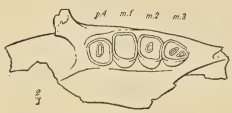


Fig. 7. *Cylindrodon fontis.* Upper jaw, twice natural size. No. 9639.

The dentition is $I\frac{1}{1}$ $c\frac{0}{0}$ $p\frac{1}{1}$ $m\frac{3}{3}$ — four cheek teeth in each jaw, as in Castoridæ, instead of five above and four below as in Sciuridæ and Ischyromyidæ. The pattern resembles that of *Steneofiber* more than any other related form, consisting in the lower molars of a deep and persistent external enamel inflection, and three fossettes corresponding in position to the internal enamel inflections of *Steneofiber* and *Castor*. Of these fossettes the median is the most persistent; the median and posterior are at first internal enamel inflections, the posterior inflection becoming a closed fossette at a very early stage of wear, while the anterior fossette is closed from the first.

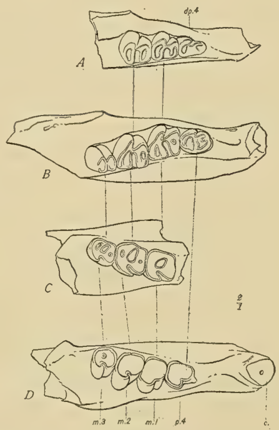


Fig. 8. *Cylindrodon fontis.* Crown views of lower teeth, showing the pattern at successive stages in their wear. All twice natural size. Nos. 9644, 9638, 9640, 9642.

It would appear from the history of those teeth that the enamel inflections did not originate on the sides of the tooth and become gradually deeper and more complicated as the tooth became more hypsodont, the fossettes being a secondary modification; but that the inflections and fossettes

have both originated from the valleys and lateral notches of a brachyodont molar, such as that of *Ischyromys*. Either of these is easily derivable from a primitive tritubercular molar such as those of the Tillodonta, but not easily from such teeth as are displayed by *Paramys* and its allies, in which, as in the squirrels, the teeth appear to be specialized and degenerate rather than primitive.

The *upper jaw* of *Cylindrodon* (No. 9639) is that of an old individual, with but little indication of the pattern left on the teeth. From what there is present it appears that the pattern exhibited a strong median external inflection and anterior and posterior fossettes, and a trace remains on p^4 of an internal inflection. The pattern was probably like that of *Ischyromys*, in having the external inflection of greater persistence and depth than the internal. In other Castoridæ this condition is reversed. The upper molars decrease in size from before backward and are of rounded peg-like outline, fossettes on all but m^1. The incisor originates just above the roots of p^4 and m^1, and is stout, not grooved, with a moderate diastema between it and the grinding teeth. The antorbital foramen is small and the palate in front of it is narrow.

The depth of the jaw of *Cylindrodon* in its anterior portion is a very marked character. *Ischyromys* comes nearest to it in this respect.

SCIURIDÆ.

Sciurus (Prosciurus) vetustus, subg. et spec. nov.

Represented by an upper jaw, No. 9626, with complete unworn dentition.

Fig. 9. *Sciurus vetustus*. Crown view of upper teeth, four times natural size. Type.

The species is smaller than *S. relictus* of the Oreodon Beds, and at least a third smaller than *S. jeffersoni* Douglas of the Pipestone Creek Beds, or *S. wortmani* of the John Day formation. It is larger than *S. ballovianus* of the John Day, the first molar (the only upper tooth

preserved in the type of *S. ballovianus*) is considerably wider transversely, its anterior cingulum much less developed, its *mesostyle* or median external cusp (between the anterior and posterior transverse ridges) more prominent. In none of the other species is the upper dentition known, so that an exact comparison is not possible.

Compared with modern Sciuridæ this species shows some interesting points of difference. It is nearest to *Sciurus*, but differs in several points of importance:

1. The cross crests on the molars are less complete, and are partly broken up into separate cusps.

2. The third premolar is a much larger tooth and has a small accessory posterior cusp.

3. The heel of m^3 bears a short transverse crest and a strong posterior marginal ridge. In *Sciurus* the posterior part of m^3 is a slightly concave flat basin.

4. The base of the zygoma is anterior to p^3.

From *Tamias* and the other modern Sciuridæ it also differs in the retention of the mesostyle, in addition to most or all of the above-mentioned points. The ridges are not so high as in *Cynomys* and *Arctomys*, and their patterns differ in various other details. I have little doubt that with more perfect material it will be necessary to place this and all the other Oligocene *Sciuri* in a separate genus, nearest to *Sciurus*, but retaining the above primitive features in the dentition, and others of more importance in the skull. But with our present knowledge the distinction in the last molar is the only one which we can predicate of all the Oligocene species in common, and this is only of subgeneric importance at best. The last lower molar in *S. relictus*, *ballovianus*, and *wortmani* exhibits a correspondingly ridged and unreduced heel to the ridged and unreduced heel of the last upper molar in *S. vetustus*.

Upper dentition, p^3–m^3	7.7 mm.
" molars m^1–m^3	5.5
P^3 transverse	0.9
" longitudinal	0.8
P^4 transverse	2.3
" longitudinal	2.0
M^1 transverse	2.5
" longitudinal	1.8

M^2 transverse	2.5 mm.
" longitudinal	1.8
M^3 transverse	2.3
" longitudinal	2.0
Width of palate, including molars	9.6

? HETEROMYIDÆ.

Gymnoptychus minor (*Douglas*).

Eumys minor DOUGLAS, Trans. Am. Phil. Soc. 1901, 16.

The position of *Gymnoptychus* and *Heliscomys* has been variously given by different authors; they are, in fact, rather remote relatives of any modern type, and combine characters of Sciuridæ, Geomyidæ, and Heteromyidæ with others peculiar to themselves or shared by the Ischyromyidæ. The dental pattern strongly suggests that of *Ischyromys*, but the resemblance may be superficial; by simplification and hypsodonty it might be converted into a Heteromyid pattern. I place the genus in this family on Scott's authority.

The present species is intermediate in size between *G. minutus* and *G. liolophus*, but nearer to the latter. The type of *G. liolophus* retains the milk dentition; a specimen of *G. minor* of corresponding age shows a smaller and shorter d_4 and somewhat narrower and smaller m_1.

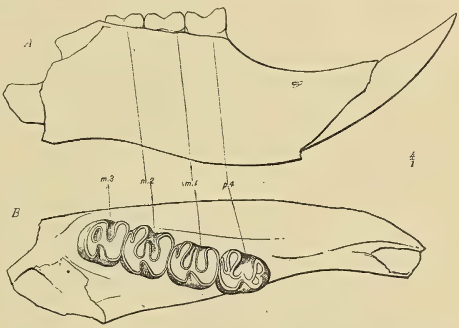


Fig. 10. *Gymnoptychus minor*. Lower jaws, four times natural size. *A*, external view, No. 9632; *B*, crown view of teeth, No. 9630.

Seven lower jaws are referred to this species.

Measurements.

	Type (Douglas).	No. 9630.
Lower dentition p_4–m_3		5.5 mm.
" molars m_1–m_3		4.0
P_4 transverse	1.3 mm.	1.3
" longitudinal	1.5	1.4
M_1 transverse	1.7	1.7
" longitudinal	1.5	1.4
Diastema behind incisor		4.3

Gymnoptychus minimus, spec. nov.

A smaller species than *G. minutus* Cope. Fourth lower premolar larger in proportion to the rest of the dentition, its anterior and posterior halves of equal width; while in *G. minutus* the anterior half of p_4 is much narrower than the rest of the tooth. The first and second molars are narrower than in *G. minutus*, and the whole molar series is thus much more uniform in width.

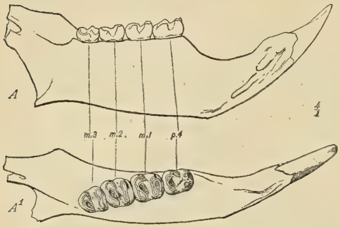


Fig. 11. *Gymnoptychus minimus.* Type specimen, four times natural size. *A*, internal, *A*¹, crown view.

Only one specimen of this tiny rodent was found by our party.

Measurements.

Length of dentition, tip of incisor to m_3		8.4 mm.
"	" molar-premolar series, p_4–m_3	3.5
"	" true molars, m_1–m_3	2.6

LEPORIDÆ.

Palæolagus temnodon *Douglas.*

This species is nearly related to *P. haydeni* of the Oreodon Beds. We have for comparison a series of about seventy-five jaws, upper or lower, but nothing more complete. Mr. Douglas distinguished the species by the presence of an antero-external groove on p^2.[1] On comparison of our series with several hundreds of jaws of *P. haydeni* in the American Museum collections, we are able to add a number of other changes less obvious on a single individual, owing to the great variation that age brings about in the characters of the teeth.

The size appears to be nearly constant, approximating that of the smaller specimen described by Mr. Douglas, which, as the first measured specimen, is the type of the species. The molars, and especially the premolars, are less hypsodont than

[1] Mr. Douglas says p^3, but this must be a slip of the pen.

in *P. haydeni*. The internal enamel inflection on the upper teeth is less deeply impressed and less persistent; it has disappeared on all the older individuals, as it does in *P. turgidus*, but at an earlier age; in *P. haydeni* only a few of the very oldest animals have lost this inflection. The last upper molar is larger than in *P. haydeni*. In the lower jaw p_3 has a less persistent external enamel inflection, so that in old individuals it becomes one-lobed, a character seen also in very old individuals of *P. turgidus*, but which I have not seen in any example of *P. haydeni*.

Measurements.

Upper molar-premolar series	12.	mm.
Lower " "	11.	
Post-canine diastema in lower jaw	8.	

Palæolagus brachyodon, spec. nov.

Palæolagus ? turgidus, P.? triplex, Douglas, Trans. Am. Phil. Soc. 1901, Vol. XX, p. 6. Not of Cope, except:

Palæolagus turgidus Cope, Geol. Sur. Canada. Contrib. to Can. Palæont. Vol. III (quarto), p. 5, pl. xiv, fig. 9. Not of previous publications.

This species is of the size of *P. turgidus*, and probably the specimens referred by Mr. Douglas to that species and to *P. triplex* really belong here. It is more brachyodont than *turgidus*, and much more so than any other species of *Palæolagus*. P^2 is smaller and more conical, m^3 appears to have been larger, the internal enamel inflection less persistent. In the lower jaw p_3 is shorter, more conical, and the inflection disappears a little earlier than in *P. turgidus*.

Twelve specimens of more or less complete upper or lower jaws represent this species in our collection.

Measurements.

Molar-premolar series, upper jaw (m^3 estimated)	16.	mm.
" " " lower jaw	15.	
P^2, longitudinal	1.5	
" transverse	2.5	

It appears probable that this species and *P. temnodon* stand in direct or almost direct genetic relationship to *P. turgidus* and *P. haydeni* respectively. The occurrence of the species of *Palæolagus* is:

Oligocene	John Day		*Lepus ennisianus*	
	White River	Leptauchenia Beds	*P. agapetillus*	*P. intermedius*
		Oreodon Beds	*P. haydeni*	*P. turgidus*
		Titanotherium Beds	*P. temnodon*	*P. brachyodon*

The evolution in *Palæolagus* ran in parallel lines in the different species, some being more progressive in one character, some in another, but none exhibiting either wide divergence or retrogression. The characters in which progress is observed, as I have remarked in a previous paper,[1] are:

1. Superposition of the *Lepus* tooth-pattern over the older and simpler one inherited by *Palæolagus*. This pattern, showing at the crown in the older species, bites continually deeper into the tooth until it entirely replaces the older pattern during the whole life of the animal.

2. Increase in length of teeth, molarization of anterior premolars, and some reduction in size of $m\frac{3}{3}$.

3. Bending down of facial portion of skull on cranial portion. This is associated with lengthening of neck and legs.

4. Increase in brain-capacity, in supra-orbital processes, etc.

5. Increase in size.

It will be observed that in the first and second characters, our two species from the Titanotherium Beds are in all respects more primitive than those of the Oreodon Beds. The difference in size is trifling if any, the third and fourth characters cannot be observed in our specimens.

PERISSODACTYLA.

EQUIDÆ.

Mesohippus westoni *Cope.*

Parts of upper and lower jaws, fore and hind feet, and many fragmentary jaws and teeth represent one or more species certainly distinct from *M. bairdii*, which does not occur

[1] Bull. A. M. N. H., XVI, 1902, p. 306.

in these beds. It is provisionally referred to Cope's species, known hitherto by an upper and two lower teeth from Swift Current Creek, Canada. These specimens will be described by Professor Osborn in a later paper.

HYRACODONTIDÆ.

Hyracodon sp.

Two lower jaws and an upper molar belong to a species of *Hyracodon*. I do not observe any important distinctions from *H. nebrascensis* in the parts preserved; but in the absence of the diagnostic teeth (upper premolars) make no specific reference.

ARTIODACTYLA.

LEPTOCHŒRIDÆ.

Stibarus montanus, spec. nov.

No. 9668, a lower jaw containing the second, third, and fourth premolars, and the first molar, enables us to place the hitherto problematic genus *Stibarus* in the Leptochœridæ.

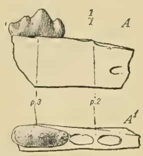


Fig. 12. *Stibarus obtusilobus* Cope, type specimen, natural size, from the Oreodon Beds of Northeastern Colorado. *A*, external, A^1, crown view.

Generic distinctions. — Molars like those of *Leptochœrus.* Premolars much like those of *Leptomeryx*, but with lower and more rounded cusps.

Specific distinction. — Third premolar with no posterior cingular cusp. The second premolar is long and laterally compressed, with three rounded cusps in line, the anterior the smallest, the median the highest. The third premolar has a similar form and composition, but the median and posterior cusps are somewhat larger, and there is a cingulum around the posterior end of the tooth. The fourth premolar is wider but not much over half as long as the third, it has a main cusp, protoconid, an anterior cusp connected by a ridge with it, a postero-internal and postero-external cusp, all worn off in the specimen and none marginal, and a

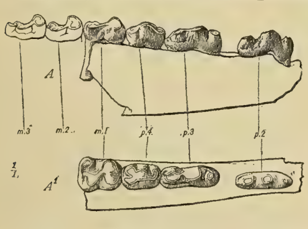


Fig. 13. *Stibarus montanus*, part of lower jaw, type specimen, natural size. *A*, external, A^1, crown view of teeth.

posterior cingulum. The first molar has four chief cusps, the external ones somewhat crescentic, the postero-internal smaller than the others, and a posterior cingulum with small hypoconid. P_2 with diastemata behind and in front of it.

No. 9670 shows the second and third molars of similar composition to the first except that the hypoconulid in m_3 is equal to the other cusps and posterior to them.

This species appears to be closely related to *S. obtusilobus* Cope, but the posterior cingular cusp (heel-cusp) is lacking, and p_2 has small diastemata before and behind it, while there are none in *S. obtusilobus*. In size and other characters it is identical as far as the type of Cope's species permits comparison.

Stibarus has been conjectured to be allied to the camels; its actual position has, I think, never been suspected. It is, in a way, a link between the Leptochœridæ and *Leptomeryx*, and makes it more certain that the former is truly an artiodactyl family. "*Leptochœrus*" *quadricuspis* Hatcher is probably a species of *Stibarus*.

Measurements.

Length p_2–m_1	27.3 mm.	
" p_2	7.	width 2.1 mm.
" p_3	7.6	" 2.7
" p_4	4.9	" 3.7
" m_1	5.0	" 4.2
Depth of jaw below p_2		7.
" " " m_1		10.

OREODONTIDÆ.

Bathygenys alpha *Douglas.*

We have three specimens referable to this genus and species: parts of two upper jaws and one lower jaw. I identify these with Mr. Douglas's species in spite of wide distinctions in the drawing of the teeth of his cotype specimen. These, if correctly drawn, could hardly be *Oreodon* teeth; they are fully as narrow and trenchant as those of *Leptomeryx*. As, however, he compares the teeth to those of *Merycochœrus*, which are short and wide and crowded, I assume that the error is in

the drawing, especially as the other drawings of the type and cotype agree well with the description and with our specimens.

The best upper jaw shows the molars and fourth premolar. The premolar is simpler than that of *Oreodon*, lacking internal cingulum and antero-external accessory ridge, and consisting of external and internal crescent, the former with slightly concave external surface, the latter with a short postero-internal cingulum. The molars are composed of four crescents, no trace of the paraconule remaining on m^2 or m^3; m^1 is a little worn, so that it is uncertain whether or not a minute *pl.* existed. The anterior halves of m^1 and m^2 are wider transversely than the posterior, the protoselene projecting further inward on the palate than does the hyposelene. The posterior half of m^3 is nearly as wide as the anterior half, as in *Agriochœrus* and the Uinta Oreodonts, instead of reduced in width as in *Oreodon* and the other Oreodontidæ. The exterior surface of the inner crescents is slightly concave, as in *Agriochœrus*, instead of strongly concave as in the later Oreodonts, or convex as in *Protoreodon*. The exterior surface of the outer crescents is nearly flat.

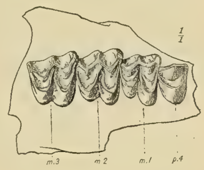


Fig. 14. *Bathygenys alpha*. Upper teeth, crown view, natural size.

The fourth lower premolar is oreodont in type, but differs from *Oreodon* and resembles *Promerycochœrus*, *Merycochœrus*, and *Merychyus*, in that the entoconid is a ridge extending down and back from the deuteroconid, instead of a separate cusp or distinct ridge. In *Protoreodon* the entoconid is rudimentary. This tooth is a little narrower anteriorly than p_4 in *Oreodon*, wider than in *Protoreodon*, *Merychyus*, or *Promerycochœrus*. The molars are proportioned nearly like those of *Oreodon*, but are more brachyodont. They are shorter, higher, and with more crescentic cusps than those of *Protoreodon*.

Bathygenys is in most respects between *Oreodon* and *Protoreodon*, but considerably nearer to the former. Some characters point toward a nearer relationship with the Merycochœrid group of Oreodonts than with *Oreodon* itself.

More complete material is needed before its place can be definitely determined.

Measurements.

Upper molars, m_{1-3}	1.7 mm.		
" premolar p^4, longitudinal	4.	transverse	5.2 mm.
Lower teeth, p_4–m_2	16.		
Upper molar m^1 longitudinal	5.3	"	6.8
" " m^2 "	5.8	"	7.3
" " m^3 "	6.2	"	7.

? **Limnenetes** sp.

A number of lower jaws and parts of jaws may be provisionally referred to this genus, although the characters of the teeth are nearer to those of *Bathygenys* than to *Oreodon;* while Mr. Douglas describes the teeth of *Limnenetes* as so like those of *Oreodon* as not to need a separate description. The premolars are narrower than those of *Oreodon*, the entoconid ridge not separated from the deuteroconid on p_4, and the structure of p_3 is intermediate between that of *O. culbertsoni* and *Merychyus elegans*, but more brachyodont than either. The lower molars are intermediate between those of *Protoreodon*, with conical internal cusps, and those of *Oreodon* with fully crescentic internal cusps. Heel of m_3 narrow, as in *Protoreodon.*

There is more than one species, and may be more than one genus, among these specimens, and it is inadvisable to attempt to place them very definitely at present.

HYPERTRAGULIDÆ.

Leptomeryx ? esulcatus *Cope.*

The type of Cope's species is an upper molar, probably m^1, from the Titanotherium Beds of Swift Current Creek, Canada.

We have a large number of parts of lower jaws and separate upper teeth, which belong to one or more species of *Leptomeryx* a little larger than *L. evansi*, but variable in size. These are referred provisionally to *L. esulcatus*, because it is within the limits of size, comes from the same geological hori-

zon, and agrees well enough with other first molars in our series. The character by which Cope separated it from *L. evansi*, the absence of defining furrows to the rib of the external crescents, is exhibited only on first molars, and not on all of these; but two other characters of more importance are seen in our material, viz.:

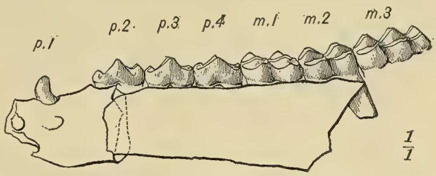


Fig. 15. *Leptomeryx esulcatus.* Lower jaw, natural size, external view, composite, Nos. 9696, 9706, 9702.

1. The median internal cusp, a strong cusp in m^3 of *L. evansi*, and a smaller one on m^2 and m^1, is quite small on m^3, and absent, or nearly so, on m^2 and m^1.

2. In the third lower premolar the protoconid has two posterior ridges, of which the internal one connects with the heel, and the external one does not; while in *L. evansi* and other species from the Oreodon and Leptauchenia Beds, the external ridge connects with the heel, and the internal one does not.

In the lower jaw I have observed no entirely constant distinctions, except in p_3. The first premolar is small, and is separated from p_2 by a diastema of about the same length as that of *L. evansi;* the size of the jaws averages larger than those of *L. evansi* from South Dakota, and all are larger than *L. evansi* of Colorado. The height of crowns and proportion of the teeth are about the same, and the premolar pattern, allowing for individual variation, is identical, except as above noted.

I have no doubt that better material will furnish more satisfactory distinctions, but, except for the characters noted above, I am unable to find any in the teeth.

Measurements.

Lower premolars p_{2-4}	19	mm.
Lower molars m_{1-3}	24	
Upper molar, m^3, antero-posterior	8.	
" " " transverse	8.5	

Leptomeryx mammifer *Cope.*

A much larger species than the preceding, size about that of *Poëbrotherium eximium.* Distinguished from *L. evansi* by the pattern of p_3, which is like that of *L. esulcatus*, but with

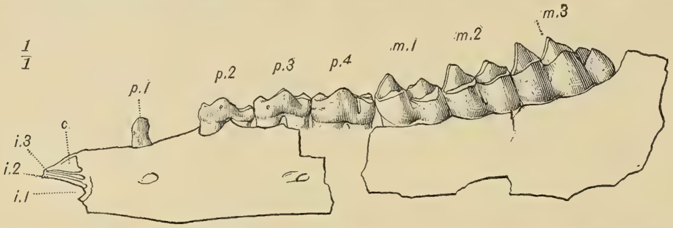


Fig. 16. *Leptomeryx mammifer.* Lower jaw, natural size, external view. No. 9684, p_3 and p_4 supplied from No. 9686.

the external ridge of the protoconid more clearly separate from the heel, and the postero-internal more clearly joined to it. The first lower incisor is large, second and third small, canine nearly as large as first incisor (larger than in *L. evansi*). First premolar equally spaced between c and p_2; remaining premolars close set. Molars an enlarged copy of those of *L. evansi.* Parts of the feet of *Leptomeryces* of appropriate size were found at the locality; they show no important distinctions either in fore or hind foot, from *L. evansi.* The upper molars have a smaller median internal cusp than those of *L. evansi.* The size is nearly a third larger, lineally.

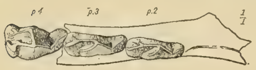


Fig. 17. *Leptomeryx mammifer.* Crown view of lower premolars, natural size. No. 9687; p_4 from No. 9689.

Lower premolars, p_{2-4}	24	mm.
" first premolar, p_1	2	
Space between c and p	17	
Lower molars, m_{1-3}	32	
Complete lower dentition, estimated	78	
Upper molar, longitudinal	9	
" " transverse	11	

CAMELIDÆ.

Leptotragulus profectus, spec. nov.

Parts of several lower jaws represent a species of Camelid nearly as large as *Poëbrotherium wilsoni*, but with brachyo-

dont molars like *Leptotragulus*. No. 9681 (type) shows p_2-m_1; No. 9682 (cotype) p_{2-3} and the root of m_1; No. 9683 a number of lower molars and milk molars. Nearly all these teeth are unworn or very little worn.

The species is of about the same size as *Leptomeryx mammifer*, but is distinguished by the camelid pattern of the pre-

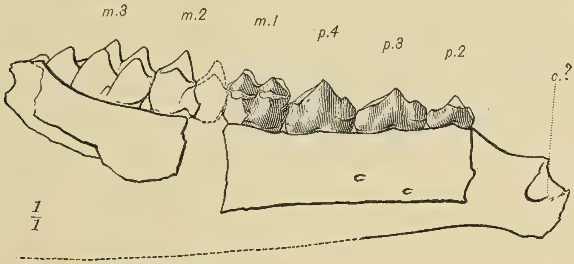


Fig. 18. *Leptotragulus profectus.* Type specimen, external view, natural size; second and third molars supplied from another individual.

molars. The molars are very difficult to separate from those of *L. mammifer;* they are a little wider and shorter-crowned, with the crescents placed less obliquely, and m_3 has but a vestigial postero-internal cusp. The fourth premolar has no deuterocone, but two strong posterior crests from protocone to heel sub-parallel, enclosing a narrow lenticular fossa. The third premolar is similar, but more compressed; the second has but one complete posterior ridge. Their pattern differs from that of *Poëbrotherium* chiefly in the completeness of the inner posterior ridge, which in *Poëbrotherium* does not reach the heel on p_3 and p_4, and is entirely absent in p_1.

The cotype shows a moderate diastema, considerably shorter than that of *L. proavus*, separating p_2 from the alveolus of a strong caniniform tooth.

The heel of the last molar in referred specimens is like that of *Leptomeryx* or *Leptotragulus*, with postero-external crescent and small antero-internal cusp. In *Poëbrotherium* is a posterior crest, not crescentic, and a small antero-internal cusp.

The species is about a fifth larger than *L. proavus*, with which its premolar pattern corresponds quite closely, according to Scott's description. The molars are a little wider and

a little more hypsodont, and the diastema both relatively and absolutely less. It is throughout very suggestive of *Poëbrotherium*, much more so than either *Protylopus* or *Leptotragulus proavus*, in the details and conformation of the molar and premolar cusps. It shows much less resemblance to *Hypertragulus*. Unfortunately no upper teeth can with entire certainty be referred to our species. Those which are doubtfully referred have the *Leptomeryx-Poëbrotherium* pattern, with strong mesostyle and a rib on the external face of the anterior external crescent, but none on the posterior; they are less extended transversely than those of *Leptomeryx*, much more than those of *Poëbrotherium*. The upper molars of *Hypertragulus* are very easily distinguished by the entire absence of mesostyle and equal development of the external ribs on anterior and posterior crescents. No upper teeth of this pattern were found in the Pipestone beds. The upper molars of *Leptotragulus proavus* are not known.

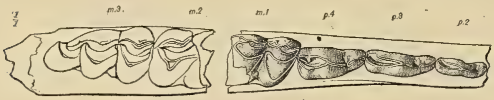


Fig. 19. *Leptotragulus profectus.* Type specimen, crown view of teeth, natural size; molars 2 and 3 supplied from another individual.

From the above facts I am inclined to believe that *Leptotragulus* — this species at least — is more nearly related to *Poëbrotherium* than Professor Scott has supposed, and that it has not much to do with *Hypertragulus*. It is probable in either case that the caniniform tooth is the first premolar. The species is really far nearer to *Poëbrotherium* than is *Protylopus petersoni;* how much of the resemblance is due to parallelism remains to be determined.

Mr. Gidley discovered last summer in the Oreodon Beds of South Dakota, a brachyodont camel, which may be a direct descendant of this species.

Measurements.

Lower premolars, p_2–p_4	25 mm.
Diastema in front of p_2	10
Last lower molar	15
Lower molars, m_{1-3} (from three specimens)	30

Article VII.—A FOSSIL HEDGEHOG FROM THE AMERICAN OLIGOCENE.

By W. D. Matthew.

The Hedgehog family (Erinaceidæ) has hitherto been found only in the Old World (Europe, Asia, and Africa). It includes three living and five extinct genera, ranging from Lower Oligocene to recent. It has been divided into two subfamilies, one including the modern hedgehogs (*Erinaceus*) and one extinct genus (*Palæoërinaceus*), the other with two modern genera, *Gymnura* and *Hylomys*,— small rat-like East Indian insectivores,— and four extinct genera, *Necrogymnurus*, *Galerix*, *Lanthanotherium*, and *Tetracus*. The subfamilies are distinguished as follows:

Erinaceinæ. — Dentition $\frac{3.1.3.3}{2.1.2.3}$. Palate imperfectly ossified. Pelvis wide. Fur with spines.

Gymnurinæ. — Dentition $\frac{3.1.4.3}{3.1.4.3}$. Palate completely ossified. Pelvis very narrow. Fur without spines.

A related but more primitive family, the Leptictidæ, is found in the American Eocene and Oligocene. The dentition is unreduced (except that there are only two upper incisors), the molars subtriangular and extended transversely, while in Erinaceidæ they are subquadrate and not extended transversely. The Leptictidæ might, however, without serious straining of relationships, be included as a primitive subfamily of Erinaceidæ, with which they agree well enough in skeleton and in most skull characters. There are four described genera, *Palæictops* from the Middle Eocene, *Leptictis*, *Ictops*, and *Mesodectes*, from the Lower Oligocene of the Western United States.

A true Hedgehog, of the Erinaceine subfamily, is represented by the front half of a skull from the Upper Oreodon Beds of South Dakota, found by Dr. F. B. Loomis of the American Museum Expedition of 1902. The dentition is that of *Erinaceus*, but the teeth are less specialized, and in several

respects resemble those of the Leptictidæ. The reduced premolars and short facial portion of the skull exclude it from the Gymnurinæ, but the teeth resemble quite nearly those of *Necrogymnurus*,[1] and the palate does not show the defective ossification of *Erinaceus*. The last molar is small and tritubercular as in *Hylomys*, *Necrogymnurus*, and *Galerix*. In *Gymnura* it is large and extended longitudinally; in *Erinaceus* small and reduced to a transverse blade. The teeth are more extended transversely than those of *Erinaceus*, and retain considerable indications of the tritubercular form of molar from which they no doubt originated. Their pattern, however, is definitely Erinaceid, with two equal outer and two equal inner cusps, a smaller separate median cusp (metaconule), and an antero-median ridge from the antero-internal cusp (protocone) to the antero-external cingulum.

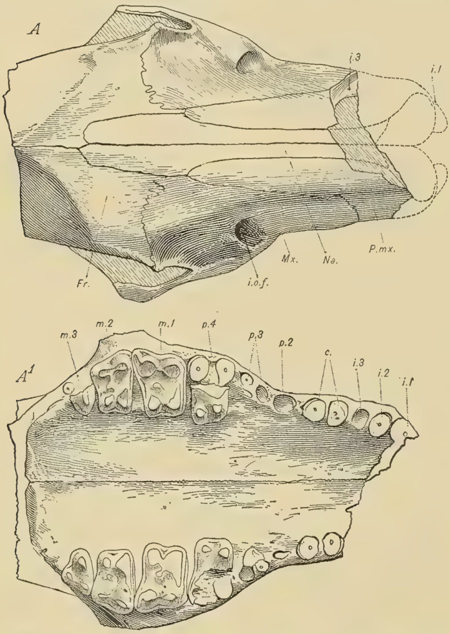


Fig. 1. *Proterix loomisi*. Type specimen, twice natural size. *A*, anterior part of skull from above; *A*¹, palate from below.

This hedgehog forms a connecting link between the Erinaceine and Gymnurine subfamilies, and to some extent between Erinaceidæ and Leptictidæ. It seems impossible to place it in any of the described genera, and it is therefore named:

Proterix loomisi, gen. et sp. nov.

Dentition $\frac{3 \cdot 1 \cdot 3 \cdot 3 \cdot}{}$ I^1 enlarged. C^1 large, two-rooted. P^2 small, one-rooted. P^3 small, three-rooted with well developed deuterocone. P^4 large, molariform, with small hypocone.

[1] Relying on Dr. Leche's very careful figures and descriptions.

M^1 and m^2 wider than long, quadrate with two external and two internal cusps of about equal size and a small separate postero-intermediate cusp (metaconule), the antero-internal cusp (protocone) with a ridge running out towards the antero-external margin. M^3 trihedral, small, not extended transversely, paraconid and metaconid equal and well separated, no hypocone. Palate completely ossified, its posterior margin as in *Erinaceus*. Skull bones arranged much as in *Erinaceus*, a well defined sagittal crest; premaxillæ not reaching frontal bones.

Measurements.

Maxillary dentition, c–m^3 inclusive	18.4 mm.
Transverse width of palate including molars	17.6
Depth of skull, junction of postorbital crests to palate	16.8
Length of three true molars (antero-posterior)	7.9
Antero-posterior diameter of m^1	3.4
Transverse " " "	4.8
Antero-posterior " " m^2	2.9
Transverse " " "	3.9
Antero-posterior " " m^3	2.0
Transverse " " "	2.8

RANGE OF THE ERINACEIDÆ AND LEPTICTIDÆ.

	Europe.	Asia.	Africa.	North America.
Modern.	Erinaceus.	Erinaceus. Gymnura. Hylomys.	Erinaceus.	
Pleistocene.	Erinaceus.			
Pliocene.	Erinaceus.			
Miocene.	Erinaceus. Galerix. Lanthano-therium.			
Oligocene.	Palæoërina-ceus. Tetracus. Necrogym-nurus.			Proterix. { Leptictis, Mesodectes. Ictops.
Eocene.				Anisacodon ? Passalaco-don. Palæictops.

Article VIII.—DIVISIONS OF THE PARIETAL BONE IN MAN AND OTHER MAMMALS.

By Aleš Hrdlička.

Plates VII–XXII and 39 Text Figures.

CONTENTS.

I. General Remarks.

The subject of divisions of the parietal bone was for the first time brought to the attention of anatomists in 1753, when Tarin, in his 'Osteographie,' described a human skull, given to him by Winslow, in which the left parietal bone was divided into two by a horizontal suture. Since Tarin, observations on parietal divisions have slowly multiplied until the present time, and the literature of the subject has grown considerably in bulk as well as importance. The authors to whom we are particularly indebted for casuistic material or scientific research in this field are W. Gruber, Welcker, Hyrtl, Toldt, and Ranke; besides these authors, however, there are others who have made especially valuable reports of individual cases or contributed more or less to the elucidation of the problems arising from the observations, such as Soemmering, Calori, Putnam, Turner, Dorsey, Fusari, Coraini, and others.

With increase in the number of observations of parietal divisions the subject extended to all stages of life in man, from adults to fœtuses and embryos. Eventually the anomaly was also found in apes and certain monkeys; no case, however, has thus far been signalled in any lower mammals than

monkeys. There are on record, considering only the complete antero-posterior divisions, 9 such cases in human embryos, fœtuses, and children, and 18 in human adolescents and adults; and of different complete divisions 2 instances in apes and 4 in monkeys.

As the material augmented there became apparent an increasing diversity in the nature of the parietal divisions. In Tarin's case the anomalous suture was complete and ran between the anterior and posterior borders of the bone in a nearly *horizontal* direction, or nearly parallel with the sagittal suture. A number of sutures of the same class was reported subsequently; but there appeared also records of divisions running *obliquely* between the anterior and posterior borders; obliquely between the posterior and *inferior* borders; and *vertically* between the superior and inferior borders of the parietal. In addition there were described in the course of time a few angular sutures, which look like combinations of vertical and horizontal, or vertical and oblique divisions. A certain amount of attention was further given to incomplete sutures and the fœtal, apparently normal, fissures in the parietal.

While the observations on divisions of the parietal bone multiplied, no serious efforts to explain the anomaly were made before the latter part of the 19th century. Soemmering, in 1826, recognized the congenital nature of the divisions, but expressed no theory as to their causation. Welcker, in 1862, was of the opinion that where the parietal bone is divided into two large portions, these portions are of a different nature from simple intercalated bones (bibl. note 17[1]; p. 109); but in 1892 (55), notwithstanding the already known work of Toldt, Welcker[2] denies the possibility of the two portions of a divided parietal developing from two centers. For Calori (1867, bibl. note 20; p. 341) the division of the parietals was the result of a separation and independent growth of a portion of the center of ossification of each bone, the separation being due to the mechanical effects and nutritive disturbance

[1] The number 17 refers to a bibliographical note at the end of the paper.
[2] Abnorme Schädelnähte, p. 21: "Von einer Entwickelung der beider Hälften des getheilten Scheitelbeinen aus zwei 'Kernen' kann wohl nicht die Rede sein."

caused by hydrocephalus. Hyrtl, in 1871 (23), misled by the occasional close relation of a horizontal or oblique parietal suture with the temporal ridge, was inclined to connect this latter with the causation of the suture. Toldt (1882–83; 48, 49) and Ranke (1899; 36) have undertaken new researches into the development of the parietal bone, and the result of these was a conclusion, arrived at by both the authors, that the parietal bone does not develop from one focus, as has been taught, but from *two* distinct centers of ossification, which ordinarily fuse early and form one, but occasionally remain separate and then give rise to a double parietal. Since Toldt's publication the theory that a double parietal center is the *original* cause of the complete antero-posterior parietal divisions has gained adherents in Putnam, Turner, Coraini, and others.

In 1896–97 Maggi, of Pavia (59, 60), announced, basing his conclusions on his own observations on human fœtuses, that the parietal bone develops from *three* centers, two of which, however, soon coalesce. In a few cases he noticed as many as four centers in the parietal. For all instances of multiple foci of ossification we find, according to Maggi, homologies among the stegocephali, batrachians, and in *Dicynodon*.

Finally, most recently (1900; 70) Frassetto, another Italian author, basing his views on some of the observations of Maggi and some old as well as new clinical material, advances the theory that the human and primate parietal develops regularly from *four* centers of ossification.

The *active* cause, or causes, which in the exceptional cases prevents the parietal centers from fusing and allows them to develop into two or more separate bones, has been touched upon only by Calori (*l. c.*) and more recently (1894) by Coraini (33), to whose views we shall return later.

II. The Published Cases of Parietal Division in Man.

Before proceeding with the series of new observations, or with individual critical considerations on the subject of parie-

tal divisions, it is essential to review with some detail the material that has already been published. In order to facilitate the task, I have collected and arranged the records in the following groups and tables. The partial and complete ANOMALOUS divisions of the human parietal bone will alone be here considered; parietal fissures in fœtal and infant bones will be treated of in a special chapter.

(*a*) *Incomplete, Anomalous Parietal Divisions in the Young.*

Hyrtl, in 1871 (23), reported, besides his other cases, one of a posteriorly incomplete division in the left parietal bone of a female fœtus before term. The division runs from a deep cleft in the middle of the anterior border of the parietal, with a slightly curved course over the eminence, ending half an inch in front of the lambdoid suture.

Ranke (36) reports numerous instances of posterior and a few of anterior parietal fissures on the skulls of 8–10-months-old fœtuses and infants; but most, if not all, of these cases belong in the category of normal divisions. The same may be said of the observations of Albinus, Gerdy, Welcker, Hamy, Augier, and Debierre (38–47).

(*b*) *Incomplete Parietal Divisions in Adults.*

Cases of this nature were reported principally by Lobstein, Broca, Welcker, Coraini, and Ranke.

In Lobstein's case (10), the left parietal of a 38-year-old white male showed a vertical division, which began in the temporal squama and ascended towards the parietal eminence. Total length of the suture, 2 inches 9 lines (7.0 cm.). No signs of any injury.

In Broca's case (38), a partial vertical suture passed into each parietal from about the point at which is located in early life the sagittal fontanel. (Allied cases are mentioned by Barkow (39), Otto (40) in Tiedemann's ' Zeitschr. f. Physiol.' (41), and by Pozzi (42).

Coraini reported a case (33) where the right parietal of a 29-year-old white male showed a superiorly incomplete

vertical division, allied somewhat in location and course to the complete vertical suture reported by Fusari (*vide* table of complete divisions).

Welcker describes briefly (55, p. 21, pl. ii, fig. 16) a case in a 50-year-old male native of New Hebrides. The skull shows on right a 1.6-, on left a 3.0-cm.-long, fairly serrated, horizontal suture running into each parietal from near the middle of its occipital border. Another skull (pl. ii, fig, 15) shows on each side a similar, 2.1-cm.-long division running forward from the middle of the lambdoid suture.

Ranke reported (36) three observations belonging to this category of cases. In one specimen the right parietal bone showed a 6.3-cm.-long horizontal suture in about the middle of its posterior portion. In the second case a similar peculiarity existed on both sides. The divisions started in about the middle of the posterior border of each parietal; it was 2.0 cm. long on the right, 1.5 cm. on the left side. The third skull showed a 5.8-cm.-long remnant of a horizontal suture running from the middle of its posterior border into the right parietal. All the three crania belonged to the old Bavarian population.

Total of incomplete parietal divisions (individual) in the young and adults (including only Broca's case of the sagittal vertical ones), 13; of which 4 horizontal were in the anterior and 5 horizontal ones in the posterior portion, 2 vertical in the superior and 2 vertical ones in the inferior portion of the parietal.

(*c*) *Complete Parietal Divisions.*

In order to present these cases with more advantage, I have arranged them into the annexed tables A and B.

Besides all the above there are in literature descriptions or mention of cases which cannot well be classified, or whose nature is doubtful. Due to the scarcity of the publications referred to, I was able to examine directly only Jung's and Gruber's communications.

Young.—Jung, C. G. (9), published in 1827 an observation on the skull of a new-born male child, which showed, besides an extreme number of Wormian bones, irregular divisions in

Total 7 cases	all whites	1 male 1 female 5 ?	1—3½ mo. 1—4 " 1—5 " 1—6 " 2 near or at term 1 ?	4 right and (1 right traces) 3 left (of 14 parietals 7 divided and on 1 traces of division)	In 4 the division runs obliquely backward and upward, in 2 it runs obliquely backward and downward, in 1 ?	In 1 case the divided parietal considerably larger, in 6 ?	In 1 skull asymmetrical, in 6 ?	In 1 hydrocephalus, in 2 defect in hard palate, in 1 cerebral hernia, in 4 ?	In 2: in 5 ?

III. Oblique Divisions Terminating in the Posterior and Inferior Borders of the Parietal.

Pandolfini & Ragnotti 1898. (58); (after Frassetto)	white	?	fœtus (age ?)	both	bilateral separation of posterior-inferior angle of the parietal	?	?	?	?

TABLES OF RECORDED COMPLETE DIVISIONS OF THE PARIETAL BONE IN MAN.

Table A. Cases in Fœtuses and the Very Young.

I. Antero-posterior Complete Divisions, Parallel, or nearly so, with the Sagittal or Squamous Sutures.

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Miscellaneous. Asymmetry.	Pathological.	Intercalated bones, etc.
Van Doeveren 1765. (4).	white	?	? "child."	left	nearly across the middle of the parietal; exact terminations not stated	?	?	?	?
Murray, A. 1797. (5).	white	male	fœtus.	both	exact terminations ?	?	?	hydrocephalus	?
Pandolfini & Ragnotti 1898. (58)	white	?	fœtus	both	exact terminations ?	?	?	?	?
Total 3 cases,	all whites	1 male, 2 sex unknown,	1 in a "child," 2 in a fœtus	1 left, 2 both (of 6 parietals 5 divided)	Exact direction and terminations in all uncertain	?	?	2 ? one hydrocephalus	?

II. Antero-posterior Complete Divisions, Moderately to Markedly Oblique.

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Miscellaneous. Asymmetry.	Pathological.	Intercalated bones, etc.
Calori, L. 1840. (12).	white	?	fœtus (one-eyed)	right	?	?	?	hydrocephalus	?
Gruber, W. 1852. (13).	white	male	9 mo. fœtus (with supernumerary digits)	left	the upper part of the parietal is higher anteriorly, the lower part posteriorly	?	?	cerebral hernia through the occipital fontanel; defect in hard palate.	?
Ramsay, H. Traquair 1863. (18.)	white	?	8–9 mo. fœtus	right	from sphenoidal angle to middle of occipital border	the divided parietal larger by ¼ than the undivided one	skull asymmetrical	"split palate"	in lambdoid and coronal sutures
Hyrtl, J. 1871. (23.)	white	female	5 mo. embryo	left	from near bregma, on the anterior, to just above asterion, on the posterior border	?	?	?	?
do. 1871. (23.)	white	?	4 mo. embryo	right	from above the middle of the anterior border to asterion	?	?	?	?
do. 1871. (23.)	white	?	6 mo. embryo.	right	from lower portion of anterior border backward and upward to the eminence and then backward and downward to below the middle of the posterior border	?	?	?	?
Bianchi, S. 1893. (31.)	white	?	3½ mo. embryo	left (traces on right)	the superior portion of the divided parietal is higher anteriorly but lower posteriorly than the inferior portion	?	?	?	interparietal and preinterparietal bones
Total 7 cases	all whites	1 male 1 female 5 ?	1—3½ mo. 1—4 " 1—5 " 1—6 " 2 near or at term 1 ?	4 right and (1 right traces) 3 left (of 14 parietals 7 divided and on 1 traces of division)	In 4 the division runs obliquely backward and upward, in 2 it runs obliquely backward and downward, in 1 ?	In 1 case the divided parietal considerably larger, in 6 ?	In 1 skull asymmetrical, in 6 ?	In 1 hydrocephalus, in 2 defect in hard palate, in 1 cerebral hernia, in 4 ?	In 2: in 5 ?

III. Oblique Divisions Terminating in the Posterior and Inferior Borders of the Parietal.

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Miscellaneous. Asymmetry.	Pathological.	Intercalated bones, etc.
Pandolfini & Ragnotti 1898. (58); (after Frassetto)	white	?	fœtus (age ?)	both	bilateral separation of posterior-inferior angle of the parietal	?	?	?	?

Table B. Cases in Adolescents and Adults.

I. Antero-posterior Complete Divisions, Parallel, or nearly so, with the Sagittal or Squamous Sutures.

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Difference in size of the two parietals.	Miscellaneous.		
							Asymmetry.	Pathological.	Intercalated bones, etc.
Tarin, Winslow 1753. (1.)	white	?	adult	left	below middle, nearly parallel with the sagittal suture, posterior termination somewhat higher than the anterior	?	?	?	A few small ones in lambdoid sut. Metopic suture.
Soemmering, Th. 1826. (8.)	white	male	30–50 y.	both	nearly along the middle of each bone	—	skull slightly asymmetrical	—	Metopic and mastoid sutures.
Welcker, H. 1862. (17.)	white	male	25 y.	left	below the middle	divided bone considerably higher than that of the opposite side	skull asymmetrical	—	Wormian bones in middle of left coronal and lambdoid, and one in the right lambdoid suture. Metopic suture.
Deslongchamps, E. 1864-'5. (19.)	New Caledonian	male	18–20 y.	left	nearly along the middle of the parietal	?	?	?	?
Hyrtl, J. 1871. (23.)	white	male	abt. 20 y.	left	between the middle and lower thirds of the bone	divided bone higher than the undivided one	skull somewhat asymmetrical	—	A small Wormian at lambda.
Zoja, G. 1874. (53.)	white	female	18 y.	right	?	?	?	?	?
Putnam, F. W 1883. (26.)	prehistoric race in Tennessee	male	young adult	left	slightly above the inferior third of the parietal; terminates somewhat higher above asterion than above pterion	divided bone higher and more bulging than the undivided one	skull asymmetrical (due partly to artificial deformation)	— (Occipital region shows considerable artificial flattening).	For. magnum angular, very large; 13 intercalated bones, moderate to large size, in the lambdoid, two in the anomalous suture, and several in the temporo-parietal articulation on right
Turner, W. 1884. (27.)	native of Admiralty Islands	male	adult	right (traces on left)	slightly above the inferior third of the parietal	?	occipital region asymmetrical	—	One intercalated bone in the anomalous, several in lambdoid suture.
Turner, W. 1891. (29.)	native Australian	male	adult	right	somewhat below the middle	?	?	—	A small Wormian in left asterion.
Welcker, H. 1892. (55.)	white (Prague)	?	adult	right	?	?	?	?	Metopic suture.
	white (München)	male	25 y.	right	somewhat below the middle	divided bone higher	?	?	?
	white (Berlin)	male	?	left	?	divided bone higher	?	?	?
	white (Leubinger skull)	male	50 y.	right	runs from slightly above the middle of the lambdoid to slightly below the middle of the coronal	divided bone larger in all dimensions	slight	—	A small Wormian in the beginning of the anomalous suture posteriorly
Curnow, J. 1893. (30.)	white	?	?	left	nearly along the middle; posterior termination slightly higher than the anterior	?	?	—	An occipital 'apex' bone.
Zoia, G. 1895. (53.)	white	male	22 y.	right	?	?	?	?	?
Dorsey, G. A. 1897. (34.)	Maori	male	adult	left	nearly along the middle, terminating somewhat higher posteriorly than anteriorly	divided bone higher than the undivided one	somewhat asymmetrical	—	One small Wormian in and one below the anomalous, and several small ones in other sutures.
Ranke, J. 1899. (36.)	white	male	adult	right (remnant on left)	between the middle and inferior thirds of the bone (the anteriorly remaining portion of the division on left runs between the fourth and inferior fifths of the bone)	divided bone on right slightly higher than the parietal of the opposite side	skull slightly asymmetrical	—	A few small Wormians in the lambdoid suture
Pitzorno, M. (after Frassetto, 1900 (54)	white	?	?	left	?	?	?	?	?
Turner, W. 1902. (.)	white	male	adult	left	runs nearly between the lowest and the upper two thirds of the parietal	?	?	?	?
Total 19 cases	14 whites 1 New-Caledonian 1 American Indian 1 Admiralty-Islander 1 Australian 1 Maori	14 males 1 female 4 ?	3 adolescents 13 adults 3 ?	1 both 10 left 2 right, with traces on left 6 right (of 38 parietals 20 divided and 2 with traces of division)	Along or nearly along the middle of the parietal..5 cases (6 parietals) below the middle..... 4 } 9 cases between the middle and lower thirds.. .5 } (9 parietals) exact location doubtful in 5 cases..............(5 parietals)	In 8 cases the divided parietal higher than the undivided one; 10 ? In 1 case, where both parietals were completely divided, the bones were nearly equal.	more or less asymmetry in 8; 11 ?	No pathological condition reported in 9; 10 ?	Metopic suture persistent in 4; mastoid sutures persistent in one to many intercalated bones in ordinary sutures in 9; none in 1; ? 8. Intercalated bones in the anomalous suture in 4.

1899. (71.)					lambda to slightly above the middle of the coronal; the right from a little below lambda to slightly above the middle of coronal			light, brittle; other skeletal abnormalities	Wormian bone at the base of the left anomalous in lambdoid suture
Total 7 cases	5 in whites 1 in an American Indian 1 in an Egyptian	2 males 2 females 1 probably female 2 ?	5 adults 1 probably adult	3 right 2 both 1 left 1 ? (of 14 parietals 9 divided)	In 7 the suture ran backward and upward (terminating higher posteriorly than anteriorly), in 2 it ran backward and downward (terminating higher anteriorly)	In 3 the completely divided bone was higher than that of the opposite side 3 ? In 1 case, where both parietals were completely divided, the bones were nearly equal	In 5 skull slightly to markedly asymmetrical, in 2 ?	In 3 — 3 ? In 1 advanced changes in all the bones; other skeletal abnormalities	In one case a persistence of metopic, in another case mastoidal sutures Intercalated bones at one of the ends of the anomalous suture in 3 2 ?

Table B. *II. Antero-posterior Complete Divisions, Moderately to Markedly Oblique.*

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Difference in size of the two parietals.	Miscellaneous.		
							Asymmetry.	Pathological.	Intercalated bones, etc.
Lucae, J. C. G. 1857. (16.)	white	?	young adult	right	from the lower end of the coronal to slightly above the middle of the lambdoid suture	divided bone considerably larger than the undivided one	skull asymmetrical	?	The illustration shows a small Wormian bone in the sagittal, and one or two small ones in the lambdoid suture
Calori, L. 1867. (20.)	white	female	37 y.	both	on right: from a point 2.2 cm. above asterion to 1.5 cm. from bregma; on left: from near lambda to a point 4.6 cm. below bregma	not much difference	skull somewhat asymmetrical	—	Intercalated bones at both ends of the left anomalous suture, and in both pterions; mastoid sutures persistent
Gruber, W. 1879. (25.)	white	probably female	adult	right	from a point 1.0 cm. above the parieto-sphenoidal suture, to a point 4.0 cm. above the parieto-mastoidal suture, 5.0 cm. below the lambda.	the divided parietal is higher than the undivided one	skull somewhat asymmetrical	—	No Wormian bones mentioned or visible on illustration
Putnam, F. W. 1883. (26.)	prehistoric race in Tennessee	male	adult (45–55 y.)	left (on right a separation of posterior-inferior portion)	left: from a cleft at a point 2.3 cm. above asterion; descends towards the anterior $\frac{1}{3}$ of the squamous suture, then obliterated, but traceable to a point 2.0 cm. above the lower end of the coronal suture. (right: the separate portion measures 2.0 cm. along the lambdoid, 3.5 cm. along the parieto-mastoid, 3.9 cm. along the squamous suture, and 4.5 cm. in a straight line from its superior lambdoid to its anterior termination)	left parietal higher than the right	skull slightly asymmetrical	— (Occiput moderately compressed)	A large Wormian bone in the cleft from which starts the left anomalous suture; a small Wormian in right lambdoid suture Persistence of metopic suture
Boyd, Stanley 1893. (32.)	white	male	adult	right	from a point "$\frac{1}{2}$ inch above the articulation with the lateral angle of the occipital" (asterion) obliquely forward and upward, to within "an inch from the anterior border, slightly above the middle"	?	?	?	?
Smith, Barclay, 1899. (35.)	Egyptian	?	?	?	"from the lambda to the pterion"	?	skull asymmetrical	?	?
Terry, R. J. 1899. (71.)	white	female	aged	both	the left anomalous suture runs from lambda to slightly above the middle of the coronal; the right from a little below lambda to slightly above the middle of coronal	?	?	bones very light, brittle; other skeletal abnormalities	A larger Wormian bone at the base of the left anomalous in lambdoid suture
Total 7 cases	5 in whites 1 in an American Indian 1 in an Egyptian	2 males 2 females 1 probably female 2 ?	5 adults 1 probably adult	3 right 2 both 1 left 1 ? (of 14 parietals 9 divided)	In 7 the suture ran backward and upward (terminating higher posteriorly than anteriorly), in 2 it ran backward and downward (terminating higher anteriorly)	In 3 the completely divided bone was higher than that of the opposite side 3 ? In 1 case, where both parietals were completely divided, the bones were nearly equal	In 5 skull slightly to markedly asymmetrical, in 2 ?	In 3 — 3 ? In 1 advanced changes in all the bones; other skeletal abnormalities	In one case a persistence of metopic, in another case mastoidal sutures Intercalated bones at one of the ends of the anomalous suture in 3 2 ?

TABLE B. *IV. Vertical-horizontal and Vertical, Complete, Divisions.*

Gruber, W. 1852. (14.)	white	?	adult	left	a vertical horizontal suture, separating a $2\frac{1}{4}$ inches high and $1\frac{3}{4}$ inches broad piece of the posterior-inferior part of the parietal	?	?	?	?
do. 1876. (24.)	white	male	adult	right	separation of the posterior-inferior portion by a slightly curved horizontal-vertical suture; antero-posterior branch of the suture begins 4.2 cm. above asterion, the vertical branch ending in the middle of the squamous suture.	?	?	?	?
Fusari, R. 1889. (28.) (Reported again in 1897 by G. Mondio 57)	white	male	23 y.	right	a complete vertical suture from the superior to the inferior border of the parietal, near its posterior third; and a horizontal division between the lambdoid and anomalous sutures, well above their middle	?	?	?	?
Total 3 cases	all whites	2 males 1 ?	all adults	2 right 1 left (of 6 parietals, 3 with divisions)	In 2 separation by a vertical-horizontal suture of the posterior-inferior portion of the parietal in 1 a complete vertical division with a transverse division of the posterior separate portion	?	?	?	?

TABLE B. *III. Oblique Divisions Terminating in the Posterior and Inferior Borders of the Parietal.*

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Miscellaneous. Asymmetry.	Pathological.	Intercalated bones, etc.
Ekmark, C. D. 1763. (3.) (Ascribed by Calori to Aurivillius)	white	?	45 y.	?	? separates the mastoid angle of the bone	?	?	hydrocephalus	?
Welcker, H. 1862. (17.)	whites	?	?	?	"several skulls," where a suture runs from the middle of the margo-lambdoideus to the inferior border of the bone	?	?	?	?
Hyrtl, J. 1871. (23.)	Gypsy	male	abt. 20 y.	right	"from the point of the occipital squama (lambda) to the middle of the squamous suture"	divided parietal somewhat longer than that of the opposite side	skull symmetrical	—	A Wormian bone in lambda
Gruber, W. 1879. (25.)	white	male	abt. 30 y.	both	on right: no details as to the terminations; on left: from "the middle of the superior border of the temporal squama, 4.5 cm. posteriorly to the wing of the sphenoid, to a point 2.5 cm. from the posterior extremity of the sagittal suture.	?	?	(Occipital flattening)	Wormian bones in various locations; an epactal bone
Gruber, W. 1879. (25.)	white	male	advanced age (all sutures patent, hence less than 50 y.)	left (traces on right)	on left: "from the middle of the lambdoid" "to the middle of the parieto-temporal suture;" (on right: from a point below the upper ⅔ of the lambdoid suture, forward and downward; incomplete inferiorly)	?	?	?	?
Welcker, H. 1892. (55.)	white	female	70 y.	left	from slightly above the middle of the lambdoid to nearly the middle of the temporo-parietal suture	?	?	?	?
Coraini, E. 1894. (33.)	white	?	adult	?	from middle of squamous to lambdoid suture	?	?	—	?
Ranke, J. 1877 & 1899. (36.)	white	?	adult	left	from upper portion of the lambdoid to near the middle of the squamous suture	?	?	—	Two "spitz" bones in lambda
do. do. (36.)	white	?	adult	right (left incomplete)	on right: a 6.5 cm. long suture, separating the mastoid angle; (on left: a 2.9 cm. long suture, in same location, incomplete inferiorly)	?	?	—	Metopic suture Wormian bones in lambdoid suture
do. do. (36.)	white	?	adult	right	from a point a little inferior to lambda towards anterior part of the squamous suture, reaching to within 2.6 cm. of the same.	?	?	?	?
Total of cases (including Putnam's described under II) = 11–12	1 in a Gypsy, the remaining in whites	3 in males, 1 in a female, in the remaining sex ?	1 adolescent, the remaining probably all adults	3 right 3 left 1 both the others? (of the 18 parietals, not including Welcker's 1862 &Putnam's cases, 12 with divisions)	the posterior termination is not restricted to any part of the occipital border of the parietal; it occurs below, at, and also above the middle of the border; the inferior termination most frequently takes place at, or not far from, the middle of the tempero-parietal articulation.	In 1 case the divided parietal is reported to have been longer than the undivided one: in the remaining cases ?	In 1 skull symmetrical; in the remaining?	In 1 hydrocephalus, 4 — the remaining ?	Metopic suture in 1 Wormian bones in 3 Epactal bone in 1 "Point" bones (in lambda) in 1 In the remaining ?

TABLE B. *IV. Vertical-horizontal and Vertical, Complete, Divisions.*

Author, year of report, No. referring to bibliography.	Race of subject.	Sex.	Age.	Parietal divided.	Location of Division; the anomalous suture runs:	Differences in size of the two parietals.	Asymmetry.	Pathological.	Intercalated bones, etc.
Gruber, W. 1852. (14.)	white	?	adult	left	a vertical horizontal suture, separating a 2¼ inches high and 1⅝ inches broad piece of the posterior-inferior part of the parietal	?	?	?	?
do. 1876. (24.)	white	male	adult	right	separation of the posterior-inferior portion by a slightly curved horizontal-vertical suture; antero- posterior branch of the suture begins 4.2 cm. above asterion, the vertical branch ending in the middle of the squamous suture.	?	?	?	?
Fusari, R. 1889. (28.) (Reported again in 1897 by G. Mondio 57)	white	male	23 y.	right	a complete vertical suture from the superior to the inferior border of the parietal, near its posterior third; and a horizontal division between the lambdoid and anomalous sutures, well above their middle	?	?	?	?
Total 3 cases	all whites	2 males 1 ?	all adults	2 right 1 left (of 6 parietals, 3 with divisions)	In 2 separation by a vertical-horizontal suture of the posterior-inferior portion of the parietal in 1 a complete vertical division with a transverse division of the posterior separate portion	?	?	?	?

both parietals. The right bone was separated into 5, the left into 3 portions.

Gorgone's case (11): According to Coraini's citation (33) it seems that Gorgone has observed a vertical division of a parietal bone in a fœtus ("essendo sempre più rara la division verticale osservata da Soemmering (?) e da me una sola volta redutta . . . in parietale però di feto").

Hartmann's case(50): Ranke mentions (36, p. 33) this case as one that possibly belongs among the lambdoid-squamous parietal divisions.

A cranium of a new-born child, with a parietal suture, has also been reported, according to Ranke (36, p. 58), in Rüdinger's catalogue of the skulls and skeletons in the Munich Anatomical Institute.

Adults.—The first of these cases is that of Sue (2), referred to by Calori and Coraini. According to a citation by Calori (20, p. 340, footnote), the specimen showed either a separation of a portion of the postero-superior angle of the left parietal, or a large Wormian bone in that location ("J'ai vu un pariétal gauche dont le quart de la partie postérieure et supérieure n'est qu'un os wormiens dont la largeur excedoit un travers de doigt").

Blumenbach's case (7): This observation is mentioned by Welcker, who says the illustration of the specimen can be seen in Blumenbach's 'Nova Pentas,' LXI. According to Welcker there is seen, on a skull of an old German, "a transverse suture of the right parietal bone, running from the middle of the temporal to the sagittal border, parallel in whole to the coronal suture."

Gruber's case (22): The right parietal of the skull of a 15–18-year-old white male showed an oblique, partly occluded division, and this was continuous with a division in the occipital squama. The illustration of the division shows none of the distinctive characters of a suture. Both Hyrtl and Ranke exclude this case from the category of anomalous parietal sutures.

Gruber's Prague Museum case: A mention is made of this case by Gruber (22). The author expresses the belief that

one of the skulls he has seen in the Prague Museum showed an antero-posterior division of one of its parietals. It is probable that this is the same case later on (1892, 55) referred to by Welcker and given in Table B, 1.

Finally there is the case of a Fidji-Islander, No. 50 in the Rabl-Rüchard's Katalogue of the Berlin collection. Welcker is of the opinion (55) that this case, referred to in the Katalogue as one presenting on the left side a Wormian bone that extends between the parietal and temporal bones from the coronal to the lambdoid suture, is only another instance of a complete horizontal parietal suture.

RÉSUMÉ.—Leaving the incomplete and doubtful cases aside, the above records comprise 51 to 52 cases with in all 58 to 59 anomalous parietal sutures running completely from one to another border of the parietal bone.

Age.—11 of the cases here considered were observed in embryos, fœtuses and a "child," 40 to 41 in adolescents and adults.

Race.—If in all the cases where the race of the subject has not been reported we assume that the subject was a white, there were then among the young all whites, among the adolescents and adults 43 to 44 (84 to 86 %) of whites and 8 (bet. 16 and 14 %) individuals of other races.

The absence of representatives of other races among the young is probably entirely due to the comparative scarcity of material from those races.

Of the individuals of other races than the white among the adults, there were

2 ancient Americans (Tennessee),
1 gypsy,
1 "Egyptian,"
1 Maori,
1 from the Admiralty Islands,
1 New Caledonian, and
1 Australian.

Sex.—Among the 29 cases in which the sex was reported 23 are males, 5 females, and 1 "probably" female. The males preponderate over the females in the ratio of nearly 5 to 1.

Side.—The anomalous divisions where their location was mentioned, were:

In the young: 4 right, 3 left, 3 bilateral, 1 left, with traces on right.

In adolescents and adults: 14 right, 15 left, 5 bilateral, 2 right, with traces on left.

Total, 18 right, 18 left, 8 both sides, 2 right and 1 left with traces on the opposite side.

Location.—In 41 instances the suture extended horizontally or obliquely between the anterior and posterior, in 16 to 17 between the inferior and posterior, and in 1 between the inferior and superior border of the parietal.

Among the young in 3 of the cases (27 %), or 5 instances, the divisions were probably horizontal (parallel with the sagittal suture); in 7 cases, or the same number of instances, (63.5 %), oblique; and in one case, or two parietals (9 %) oblique infero-posterior. Among the adolescents and adults the division was in 19 of the cases, or 20 instances (52.6 %), horizontal; in 7 cases, or 9 instances (18.4 %), oblique antero-posterior; in 11 to 12 cases (28.9 %), oblique infero-posterior; in 2 cases (5.3 %), angular infero-posterior; and in 1 case (2.6 %) vertical, or infero-superior, with a partial horizontal ramus.

Of the 25 horizontal divisions all, so far as reported, ran at or below (the majority) the middle of the parietal bone. Of the 16 antero-posterior oblique divisions, 4 in the young and 7 in the adults ran in a backward and upward, 2 in the young and 2 in adults in a backward and downward direction from the anterior border of the parietal: in one instance the exact course of the division is uncertain.

Size of the parietals.—The divided parietal bone is generally larger than the undivided one in the same skull; the excess in size is mainly at, or nearly at, a right angle to the anomalous suture.

Asymmetry.—Unless both parietals are completely and similarly divided, more or less asymmetry of the skull is probably the rule. This asymmetry is principally due to the unequal growth of the two parietals.

Pathological.—Of the *fœtal* skulls every one in which we have a report on this point, showed some pathological or teratological features. There were in four specimens two hydrocephali, two defects in the hard palate, an abnormally

large posterior fontanel with a cerebral hernia, one instance of monoculism, and one of polydactyly. One case of a hydrocephalus is reported among the adolescents and adults.

Intercalated Bones.—One to a considerable number of such bones of various sizes were present in a large majority of the cases. In 7 instances there was one or more Wormian bones present at the beginning or in the course of the anomalous suture.

Persistence of Early Normal Sutures.—The persistence of the metopic or frontal suture is reported in 6, mastoid sutures in 2, transverse occipital in 1 of the adults.

Characteristics of the Anomalous Sutures.—The antero-posterior horizontal or moderately oblique parietal sutures in adults are generally well serrated in their middle or their middle and posterior thirds; anteriorly, however, these divisions are often of a more or less squamous character, the border of the inferior overlapping that of the superior portion (cases of Lucae, Hyrtl—20-year male, Gruber—"probably female," Putnam, Ranke). The infero-posterior divisions show on the average a less pronounced serration than the antero-posterior ones; occurrence of squamous character is uncertain.

The relative persistence of the anomalous divisions seems occasionally to equal that of the majority of the normal parietal articulations, or even to slightly exceed the same. In Soemmering's, one of Hyrtl's and Ranke's cases, the anomalous sutures were still externally patent, while some of the normal parietal articulations showed traces of occlusion. In Dorsey's case the anomalous division was patent externally, but occluded ventrally, and there was a partial synostosis in the sagittal suture. On the other hand, some of the partial divisions in adults seem to point to an occasional early occlusion of the supernumerary suture.

The preceding data make it evident that divisions of the human parietal bone may be encountered at all ages from the embryonic to advanced adult life. The process of suture obliteration may somewhat interfere with the detection of such divisions in the aged.

Considering the relative supply of material, it seems that the divisions occur more commonly in the colored races than in the whites; this point, however, cannot be decided before there are opportunities of examining very much larger numbers of crania belonging to the various colored races than has been possible up to the present time. The anomaly is certainly exceedingly rare in both prehistoric and more recent native Americans.

A very striking feature is the predominance of parietal divisions in males. The proportion of 5 males to 1 female might possibly be slightly altered if we had reliable records as to the sex of the subject in all the cases.

Parietal divisions in man are more often uni- than bi-lateral (in about the proportion of 5 to 1). The unilateral divisions occur with about equal frequency on the two sides; apparently there is no cause in man which would influence the phenomenon to appear more frequently on one side than on the other.

According to their terminations and direction, the anomalous parietal sutures can be, as has been done in the tables, arranged into several classes. The antero-posterior divisions predominate over the infero-posterior ones, but this may be due to the fact that the former, through their more striking character, have received greater attention (*v.* Ranke, 36, p. 33). The vertical or infero-superior sutures are apparently exceedingly rare.

Of the antero-posterior divisions, the oblique are somewhat more common than horizontal ones in the young, while in adolescents and adults the condition is reversed, the oblique sutures being in a decided minority. It is not improbable that some divisions, originally oblique, do gradually, as the bones grow, assume a more horizontal direction.

The fact of the existence in the four skulls of fœtuses at or near term, in which a parietal division was observed, of pathological or teratological abnormalities, can hardly be without a special significance. We shall return to this point in the concluding chapter. There cannot, however, before we possess additional data, be much meaning attached to the

frequent presence of intercalated bones in crania with a parietal division, or to the occasional persistence in such specimens of the metopic or mastoid sutures. In some reports these features are not touched upon, in consequence of which the figures cannot well be reduced to percentages and used for comparison with observations on similar conditions in crania which do not present a division of the parietal. The occurrence of Wormian and even fontanel bones in crania in which the parietal bones are normal is very common, nor is it rare to find in such specimens, as is well known, a complete metopic or a more or less preserved mastoid suture.

III. The Published Cases of Parietal Division in Apes and Monkeys.

The data and remarks in the preceding chapter cover briefly the accumulated published material on parietal divisions in man. In addition we have in literature a smaller number of observations, by Gruber, Coraini, Maggi, Ranke, myself, and Frassetto, on similar anomalies of the parietal bone in the apes and monkeys. These observations, which by their nature add much additional interest to the whole matter of parietal divisions, are as follows:

APES: COMPLETE PARIETAL DIVISIONS.

Ranke's Case: Complete Division of a Parietal Bone in an Orang.[1]— Among the 245 orang skulls of the Selenka's collection in the München Anthropological Institute. Ranke found one in which the right parietal bone is divided into a larger upper and a smaller lower portion by a horizontal suture. The skull is that of an adolescent female. The abnormal suture "runs nearly parallel with the sagittal suture"; but its posterior end bends downward and ends on the inferior border of the bone, near the junction of the squamous with the lambdoid suture. The abnormal suture shows but little serration and is squamous in character, the lower overlapping the upper portion of the bone. The height of the superior is

[1] *L. c.*, p. 310.

to that of the inferior portion, at the anterior border of the parietal, as 3 to 1 (6.0 and 2.0 cm.). The lower portion projects further forward than the upper.

Frassetto's Case (69). — The right parietal of a well-formed, slightly asymmetrical skull of an orang (adolescent) shows

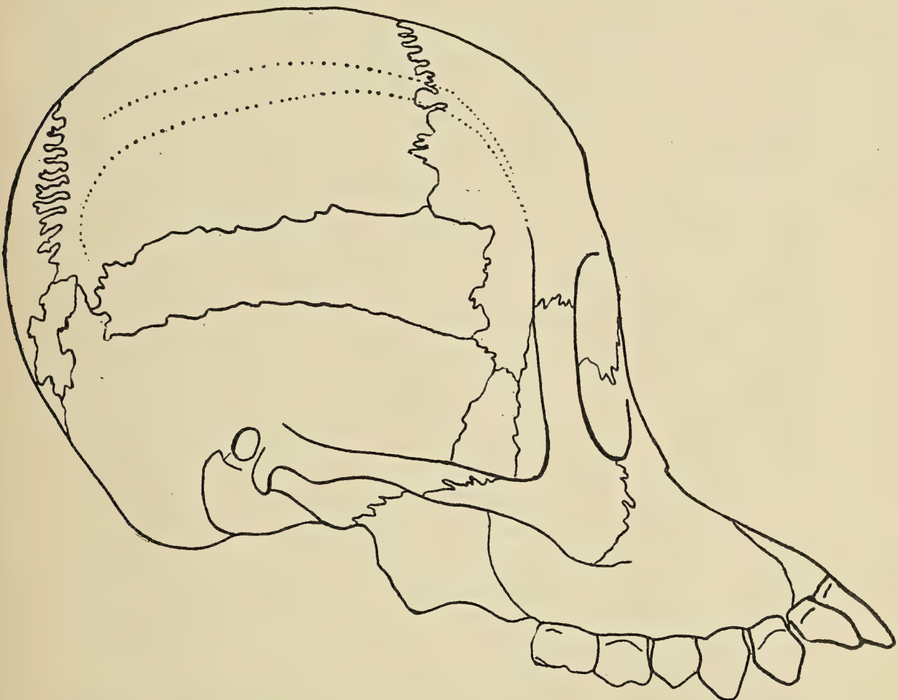


Fig. 1. An Orang, showing a complete antero-posterior parietal division. (After Ranke.)

an oblique, complete division, beginning 0.7 cm. below the lambda and ending in the coronal below its middle. The posterior half of the anomalous suture is well serrated, the anterior half simple. A moderate-size Wormian (more properly fontanel) bone is seen in the posterior end of the suture. The right parietal bone is slightly larger than the left. (The division here described is strikingly similar to those reported in a human subject by Terry, Table B, II.)

My Case in a Chimpanzee (37). — A bilateral complete divi-

sion of the parietal bones in the skull of a 9-year-old male chimpanzee ('Chico').

"The skull shows in general a good development and an almost perfect symmetry. The capacity of the brain cavity, measured according to Flower's method, is 390 c.c.

"The masculine features of this skull, and particularly the temporal ridges, are not quite as marked as those of another skull of an adolescent male chimpanzee in the American Museum. The temporal ridges are slightly prominent, and in their middle third, over part of the frontal and the parietal bones, not more pronounced than in some human crania. They are, however, situated very high. Their upper lines or boundaries touch each other over a part of the sagittal suture, a little back of the bregma; while the lower lines approach to within 6 mm. of the sagittal suture. The supraorbital ridges are not very massive, although prominent to such a degree that, when the skull rests on the occipital condyles and on the teeth, the plane of the orbits is almost vertical. The sagittal crest is insignificant; the occipital crest is high, but not very massive. The zygomatic arches are less strong than they are in an average white male; and the mastoids are small, even smaller than in an average adult white female.

"The second dentition is incomplete; the third molars have not reached the level of the opening of their sockets. The condition of the sutures, so far as their patency is concerned, does not bear the same relation to the stage of dentition as it does in man: all the sutures of this skull are more or less obliterated. There are no signs on any part of the skull that point to the closure of any of the sutures as premature.

"The temporo-parietal sutures, with the exception of 8 mm. of the anterior end of the suture on the right side, are both entirely closed and hardly traceable. The coronal suture is partly open on the left, and wholly open on the right, up to a point a little below the middle of the anterior border of the parietal bone. At this point on each side, the lower portion of the coronal suture appears as if it bent backward and continued as the anomalous suture; the upper portion of the coronal, particularly on the right, is completely obliterated,

though still traceable. There are no signs left of the sagittal and lambdoid sutures, and only the basal portions of the temporo-occipital articulation remain. The palatine sutures, also, are entirely obliterated.

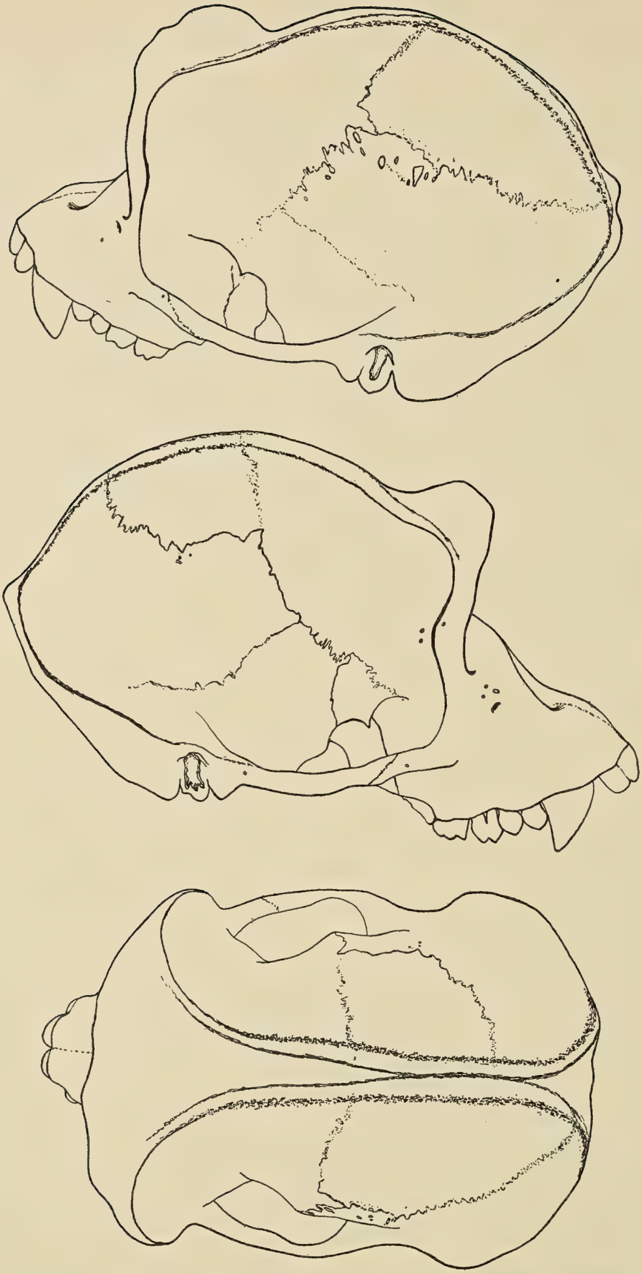
"The skull shows no important anomalies besides the division of the parietals.

"The divisions of the parietal bones begin on the left 32 mm., on the right 28 mm. (measured with a tape), above the point of junction of the coronal and temporo-parietal sutures. From the point where the anomalous sutures leave the coronal suture to the bregma the distance on the left is 44 mm., on the right 42 mm.

"The excess of size of the left over the right parietal bone along the coronal suture (6 mm.) compensates the greater height of that portion of the right temporal squama which articulates with the frontal bone. Measured across their middle from the temporo-parietal suture, the two parietals appear to be almost of equal size (left 82 mm., right 80 mm.). In an antero-posterior direction, from the beginning of the division to the middle of the parietal portion of the occipital crest, both bones measure the same, namely, 75 mm.

"The division in the left parietal begins at a V-shaped cleft, which is filled with a process of the frontal bone. There are slightly distinct markings on the bone and a number of insular ossicles, which make it probable that the cleft had been originally much greater and was largely filled by a Wormian or, rather, a fontanel bone, the lower border of which has subsequently united with the parietal.

"For 30 mm. from its beginning the abnormal suture proceeds directly backward, and to this extent shows but little obliteration. The original cleft has, it seems, extended up to this point. From here the suture takes a slight bend upwards, and proceeds almost directly upwards and backwards, becoming gradually obliterated, until it disappears at the temporal ridge, 16 mm. from the median line. Originally the suture must have terminated on the posterior border of the parietal bone, not far from the lambda. The whole suture shows fairly good serration. The coronal suture on this side,



Figs. 2, 3, 4. Skull of an adolescent male Chimpanzee, showing a bilateral parietal division.

below the division, shows serration about equal to that of the abnormal suture; the obliterated portion above this was, so far as can be seen, more simple.

"On the right side the division of the parietal may also have begun with a cleft in the anterior border of the bone, but, owing to the advanced state of obliteration of the upper portion of the coronal suture on this side, the existence of the cleft cannot be fully ascertained. Here also the abnormal suture, at first wholly open, runs for the first 26 mm. directly backwards; at this point the suture, still quite patent, takes a turn somewhat sharper than that on the left, and proceeds for 16 mm. backwards and upwards; here it takes a second turn, and proceeds almost directly upwards towards the sagittal suture. This last portion of the abnormal suture is considerably obliterated, and on and beyond the temporal ridge is scarcely traceable. The point at which the division has reached the sagittal suture is situated a little behind the middle of the latter. The abnormal as well as the open part of the coronal suture on this side shows a simpler serration than the corresponding sutures on the left side.

"In this specimen there is on neither side any encroachment of the lower portion of the parietal bone upon the frontal, such as Ranke lays stress on in the case of his orangs. A second skull of an adolescent male chimpanzee, in the Museum of Natural History, has a decided bend in the coronal suture, not unlike that which Ranke describes, and which, as he thinks, generally indicates an old parietal division; but in this case the bend is situated between the inferior and superior boundaries of the prominent temporal ridge, and apparently owes its origin to the latter."

The main interest in the case just described centers in the so far unique (up to the publication of 37) location of the abnormal sutures, and in the clearness with which the two divisions appear as equivalent and of the same origin, although one divides the parietal completely, while the other is restricted to one of its angles.

In 1901 (73) there appeared in the Proceedings of the

Fig. 5. Partial anterior parietal divisions in Apes. (After Ranke.)

Anatomical Society of Great Britain and Ireland, with some notes on a demonstration before the Society by Dr. L. H. Duckworth, a drawing of a "Chimpanzee Skull in Museum of Copenhagen," in which the left parietal shows a division much like that on the same side in my case, but terminating more anteriorly in the sagittal suture. No description whatever accompanies this illustration.

CASES OF INCOMPLETE DIVISIONS OF THE PARIETAL BONES IN APES.

Orangs.—Among the 245 orang skulls examined by Ranke (36, p. 314 et seq.), there were 13 with an incomplete parietal division. This began invariably in the coronal border of the parietal, at the point where the coronal suture makes the bend

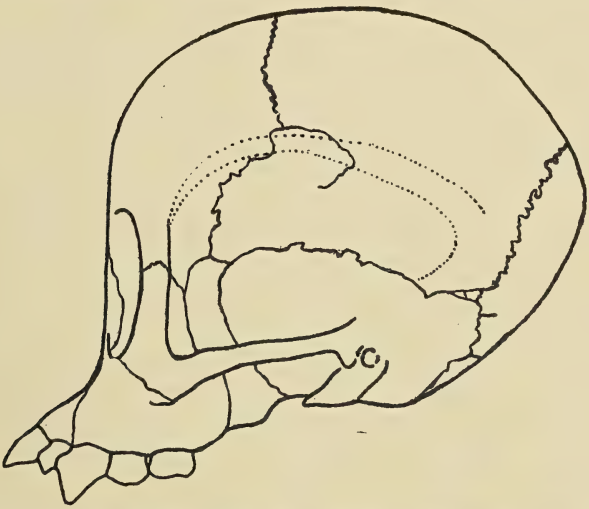


Fig. 6. The skull of a young Orang, showing a partial anterior parietal division.

forward, and passed horizontally into the bone. All the 13 skulls with parietal divisions belonged to younger animals.

Gorillas. — Among 8 young gorilla skulls 1 showed a short suture running backward from about the middle of the anterior border of the left parietal.

Chimpanzees. — Among 11 young Chimpanzee skulls there

was one with an incomplete suture in each parietal; the division proceeded from the middle of the coronal border to the middle of each bone.

Gibbons. — Among 70 skulls of *Hylobates concolor* there is no one with any parietal division.

The only other observer who reports incomplete parietal sutures in apes is Frassetto (67). He saw a bilateral short anterior division in three orangs, and in one of these there was in addition on the left side a 6-mm.-long vertical fissure in the posterior third of the superior border of the parietal.

MONKEYS: COMPLETE PARIETAL DIVISIONS.

Gruber's Case in a Monkey (15). — "*Simia silenus*" (apparently adolescent, sex ?), presenting an oblique-vertical division of the left parietal.

"The left parietal is divided, by an angular suture, composed of a horizontal and a vertical branch, into two segments, one quadrangular, situated antero-superiorly, the other triangular, situated postero-inferiorly."

The horizontal branch of the anomalous suture, as seen on the figure, begins a short distance above the squamo-coronal point on the coronal border of the parietal, runs for a short distance downward and backward, then makes an angular turn and runs backward and somewhat upward, diverging from the squamous suture to or slightly beyond the beginning of the last fourth of the antero-posterior dimension of the bone. At this point the "horizontal" branch meets the vertical one, the two making a moderate obtuse angle open forward and upward. The vertical branch is seen to run upward and slightly backward, and end at or slightly before the lambda. The anterior branch deserves more the term oblique than horizontal.

The anomalous suture is moderately serrated and, with the other cranial sutures, appears to be still open.

There is a large, rhomboidal Wormian bone in the lower part of the coronal suture.

Welcker's Case (55). — The anterior-superior angle of the right parietal of a *Semnopithecus* is separated by an anomalous

suture running in a curve (convex downward) from the middle of the coronal to the middle of the sagittal suture.

Coraini's Case (*a*) (33). — A vertical division of the left parietal in an "*Arctopithecus*"; a partly obliterated oblique division of the parietal bone on the right side; and a double division in the left temporal squama.

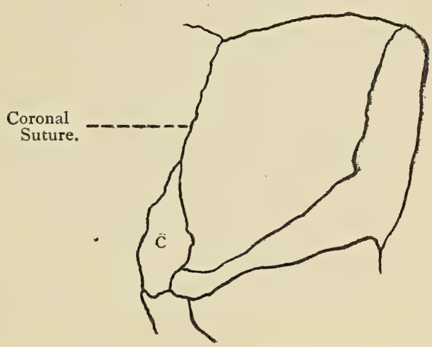


Fig. 7. Gruber's case of a parietal division in a monkey. *C*, a rhomboidal Wormian bone in the lower part of the coronal suture.

Cranium regular; all normal sutures patent, with the exception of the anterior portion of the right squamous suture, which shows some occlusion.

The left parietal bone is divided into a large, quadrate anterior and a narrow posterior trapezoidal portion.

On the right side an oblique, partially obliterated suture runs from the sagittal border of the parietal, from a point a few mm. anterior to the superior termination of the suture on the left side, to the sphenoidal angle.

The left temporal squama shows one partly oblique and one vertical division (details given not sufficient to determine exact location).

Coraini's Case (*b*) (33). — A vertical division of the left parietal bone in a *Cercopithecus*.

Cranium regular, all sutures patent, a persistence of metopic suture. A bregmatic bone; Wormian bones about left pterion; a separate bone in lambda.

The anomalous suture runs from the middle of the superior to the inferior border of the parietal, diverging a little from the lambdoid suture.

Right parietal bone normal and of about the same size as the left one.

Maggi's Cases: Macacus cynomolgus (63). The right parietal is divided into two by a vertical suture running from the

sagittal at the parietal foramen to the temporo-parietal suture.

Macacus cynomolgus (63). Frassetto mentions this case (70) as one of a bilateral, complete, horizontal parietal division. No description in 63.

Cercopithecus (?) (63). An oblique, complete, unilateral parietal division. The anomalous suture runs from the superior part of the coronal to the inferior part of the lambdoid suture. No further particulars.

Cercopithecus patas (63). Mentioned in Frassetto as a case of a complete vertical parietal division on the right side.

Frassetto's Cases: Cercopithecus (?) (68). A complete vertical division of the left, incomplete, superior, similar and opposite division of the right parietal.

Cercopithecus (67). A young animal. The left parietal is divided by a complete vertical suture, and the posterior separate portion is subdivided into a superior and an inferior segment by a horizontal suture (parietale tripartitum). On the right parietal can be seen traces of a superior vertical and a horizontal division.

MONKEYS: INCOMPLETE PARIETAL DIVISIONS.

Maggi's Cases: A *Cercopithecus patas* (63) shows a bilateral incomplete vertical division starting on each side from the sagittal suture at the parietal foramen; also another superior, vertical, incomplete division on the left side somewhat more anteriorly. No one of these divisions is very long.

Cercopithecus campbelli (63). An incomplete division in the superior border of the right parietal anterior to the parietal foramen.

Ranke's Cases (36, p. 44). — A skull of *Cynocephalus ursinus* shows an incomplete suture passing from the coronal border into each parietal.

A skull of *Mycetes seniculus* shows a 4-mm.-long suture, passing from its anterior border into the right parietal.

Frassetto's Cases: Cercopithecus (?) (67, 70). The superior border of each parietal shows a short vertical division (not opposite).

Cebus fatuellus (67, 70). A horizontal fissure in the anterior border of each parietal somewhat below the middle (right 1.2, left 0.5 cm.).

Cebus (67, 70). Traces of lower half of vertical suture in the right parietal.

Résumé of Published Cases of Parietal Division in Apes and Monkeys.

Apes. — 1. A complete antero-posterior, nearly horizontal division of the right parietal, with a remnant of a similar division in the left parietal, in an adolescent female orang (Ranke).

2. A complete oblique division, upper part of lambdoid to below middle of coronal suture, on the right side in an adolescent orang (Frassetto).

3. A bilateral complete division, oblique (antero-superior) on the left, vertical-horizontal (antero-superior) on the right side, in a nearly adult male chimpanzee (Hrdlička).

4. A complete oblique antero-superior division in the left parietal of a chimpanzee (Copenhagen Museum).

Incomplete horizontal divisions in the anterior portion of the parietal observed by Ranke in 13 younger orangs, 1 gorilla, and 1 chimpanzee, and by Frassetto in 3 orangs.

Monkeys. — 1. A complete oblique (sphenoidal angle-lambda) division in the left parietal of a "*Simia silenus*" (*Macacus silenus*, or *Semnopithecus silenus*) (Gruber).

2. A complete vertical and a partly obliterated oblique (sphenoidal angle-sagittal suture) division of respectively the left and right parietal, in an "*Arctopithecus*" (Coraini).

3–6. A complete vertical division in the left parietal bone of an adolescent *Cercopithecus* (Coraini); in a *Macacus cynomolgus*, right (Maggi); in a *Cercopithecus patas*, right (Maggi); and in a *Cercopithecus* (?) on both sides, right incomplete (Frassetto).

7. In one *Cercopithecus* (?) Frassetto found a complete vertical and posterior horizontal suture on the left, and traces of a vertical and a horizontal suture on the right.

8. In one *Cercopithecus* (Maggi) a suture runs obliquely in one of the parietals from the superior part of the coronal to the inferior part of the lambdoid suture.

9. In a *Macacus cynomolgus* there is a bilateral antero-posterior parietal division (Maggi).

10. In a *Semnopithecus* an anomalous suture runs from the middle of the coronal to the middle of the sagittal suture (Welcker).

Incomplete horizontal divisions in the anterior portion of the parietal observed by Ranke in one *Cynocephalus ursinus* and one *Mycetes seniculus*, and by Frassetto in a *Cebus;* incomplete vertical divisions in the sagittal border of the parietal are reported in two *Cercopitheci* by Maggi and in one *Cercopithecus* by Frassetto, and vertical division in the inferior portion of the parietal in one *Cebus* by Frassetto.

The more remarkable features of these records are the occurrence of comparatively numerous vertical and some very oblique, but only two (one case) of complete horizontal sutures in the monkeys; the frequency of remnants of divisions and their uniformly anterior location and horizontal direction in the orangs; and the antero-superior divisions in the chimpanzees. These conditions not only enlarge the field of possibilities of parietal divisions, but they also directly urge a thorough inquiry into the subject of development of the parietal bones in various mammals.

IV. New Material.

To the preceding two categories of published cases I am able to add some new observations of parietal divisions, particularly in monkeys. It was a parietal division in a monkey skull that attracted my attention to the subject in 1897, and since then I have been able to gather quite a number of other cases of the anomaly in these animals.

My examinations have not been confined to monkeys, but have extended, thanks to the courtesies of the various curators, over a large series of human and various mammalian crania, including the collections in the anthropological and zoōlogical departments of the American Museum of Natural History

and the anatomical collection in the Medical Department (College of Physicians and Surgeons) of the Columbia University in New York, and parts of the anthropological collections in the Peabody Museum, Cambridge; the Museum of Sciences and Art, Philadelphia; and the National Museum, Washington. The material examined comprises nearly 3000 Indian and 400 white and negro crania; a little over 400 skulls of apes and monkeys; and a little over 2000 skulls of other mammals.

The most striking results of my search, so far as confined to adolescent and adult crania, are the comparative frequency of parietal divisions in monkeys, particularly in certain of their species; the great scarcity of the anomaly in man; and its complete, or almost complete, absence in other mammals. Among 14 skulls of apes one specimen (chimpanzee) presented a bilateral complete parietal suture; among 392 skulls of monkeys of various kinds, there were 17 with complete and 35 with incomplete, single or multiple, parietal divisions. On the other hand, among the 3400 human adolescent or adult crania I saw but two with complete, none with large, and but six with minor partial divisions in the parietal bone. The two cases with complete sutures were those previously published by Professor Putnam, in Prehistoric Indian Crania from Tennessee. Among the skulls of various mammals other than man, apes, and monkeys, there was but one with a complete parietal suture, and even in this isolated case the congenital character of the division is not as clear as would be desirable. There were also found in these animal skulls three cases with a separation of a portion of one of the angles of the parietal; and there were many incomplete sutures in the parietal bones; but these sutures are of a different origin and meaning from the majority of those thus far considered, and will, like the more or less normal parietal fissures in the young, be dealt with in a special chapter.

GROUP I. CASES IN MAN.

Having received permission from Professor Putnam to re-examine the two Tennessee Indian crania with parietal

divisions, I am able to supplement the previously published facts concerning the specimens by a few additional points of interest and by illustrations of the divided parietals.

Putnam's 1st Case (26). *Original Report.* — A male adult cranium, from a prehistoric stone grave in Tennessee, showing an antero-posterior, almost horizontal, division of the left parietal (spec. 27205, Peabody Museum, Cambridge).

The skull is relatively broad and short, and shows a marked occipital compression. "The left parietal is divided into two quadrilateral pieces by a transverse serrated suture, crossing the bone at one third its height above the squamous suture. The transverse arc formed by the divided left parietal exceeds that of the normal right parietal by one fourth. The longitudinal arc of the left parietal is also greater than that of the right parietal, and the left side of the skull bulges upwards and outwards. The abnormal suture encloses a pair of Wormian bones (size 3 of Broca's scale)." "The coronal and sagittal sutures are simple and all the sutures except the basilar are open." The sutures of the back of the skull are crowded with supernumerary bones (over 20 in number).

Additional data and measurements. — The skull shows an apparently congenital absence of both upper lateral incisors; the other teeth are all present, well developed, and healthy. The foramen magnum is very large (diam. antero-posterior max., 3.7 cm.; diam. lateral max., 3.6 cm.), and of a somewhat irregular hexagonal form; projecting into the foramen from the middle of its anterior border is a 0.4-cm.-high bony tubercle. The skull is asymmetrical, which is partly due to the greater height and bulging of the left parietal, and partly to the somewhat one-sided occipital compression. At least one, and possibly two, of the separate bones in the lambdoid suture must be considered as portions of the occipital squama. Occlusion is manifested in the internasal, left masto-occipital, and about a few of the intercalated ossicles in the lambdoid suture. The skull as a whole is large and shows nothing pathological. There is no division on the right side, but the anterior border of the right parietal shows, in a position corre-

sponding to the point at which the anomalous suture begins on the left, a marked indentation.

Surface Measurements of the Two Parietal Bones.

Junction of the squamous and temporo-sphenoidal sutures to the anterior termination of the anomalous division.......	left 4.6 cm.	right —
Junction of the squamous and temporo-sphenoidal sutures to bregma..	" 13.4 "	" 12.15 cm
Infero-superiorly at middle..............................	" 14.5 "	" 12.2 "

(The posterior height cannot be measured accurately, the left asterion being obliterated and the right affected by the Wormian bones; but the height of the left parietal exceeds also here quite considerably that of the right one. The greatest height of the lower separate portion of the left parietal is found about 2.0 cm. anteriorly to the lambdoid suture, amounting to 5.5 cm. The superior piece measures 6.9 cm. along the lambdoid suture.)

Antero-posteriorly, from the middle of the coronal suture to a point about midway between the asterion and lambda, on the anterior boundary of the intercalated bones, the left parietal measures 12.6, the right 12.7 cm.; to the posterior boundary of the intercalated bones the left is 16.1, the right 15.1 cm.

Putnam's 2d Case (26). *Original Record.* — A brachycephalic, posteriorly somewhat compressed, adult male skull, from a prehistoric stone grave in Tennessee, with an oblique division of the left parietal and an angular separation of the postero-inferior extremity of the right parietal (spec. 12797, Peabody Museum).

"The extra suture (on left) springs from the left arm of the lambdoid suture at the junction of its middle and lower third, and passes nearly horizontally half way across the parietal. It is then deflected and runs towards the pterion. Posteriorly this suture is finely dentated, but anteriorly it becomes simple and is so much obliterated that it is impossible to trace its entire course. A large Wormian bone occurs in the left arm of the lambdoid suture at and above the origin of this anomalous suture."

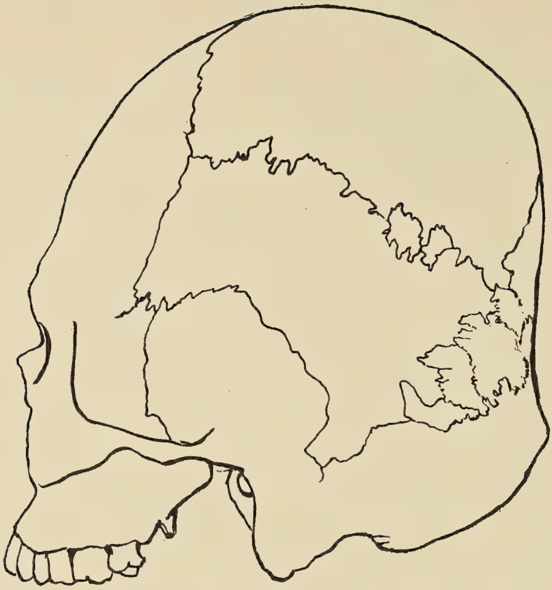


Fig. 8. Putnam's first case of parietal division. (Drawn from a photograph.)

Fig. 9. Putnam's first case of parietal division, posterior view. (Drawn from a photograph.)

"The postero-inferior angle of the right parietal of this skull is also developed from a separate center. It is united with the main portion of the bone by a simple suture running from the squamous suture almost horizontally till it approaches the lambdoid, when it turns downward and enters this suture at a point opposite the middle of the squamous border of the intercalated bone."

"This skull has simple sutures which are open except near the pterion" (coronal).

Additional Remarks. — The skull is very large, measuring 1825 c.c. in capacity. It shows but a little asymmetry, and that mainly due to the artificial occipital compression. Nothing pathological. A number of sutures show more or less occlusion (partial synostosis in both malo-maxillary, left zygomatic, internasal, and all the intraorbital sutures; a complete occlusion of the coronal suture on both sides below the temporal ridge; traces of occlusion about lambda and in left lambdoid suture; and advanced occlusion in both spheno-parietal and both temporo-occipital articulations). The lambdoid suture contains four smaller Wormian bones, one of which is situated in a pronounced cleft from which begins the left anomalous division.

The division on the left runs in an irregular way across the whole length of the bone. The cleft from which it starts posteriorly extends along the lambdoid suture from a point 2.0 cm. to one 5.5 cm. above asterion, and is nearly as deep as high. The suture runs at first horizontally, then, somewhat anterior to the middle of the parietal, it bends downward, but soon bends again and proceeds forward, and finally forward and upward, terminating at a point about 2.2 cm. above the lower end of the coronal suture. The anterior portion of this anomalous suture was squamous, the posterior serrated. The anterior fourth of the division is totally occluded and hardly traceable; the occlusion diminishes backward, and the posterior three fifths of the suture are largely patent.

The anomalous suture on the right side is open, and of a moderately squamous character, the border of the lower overlapping somewhat that of the upper portion of the parietal.

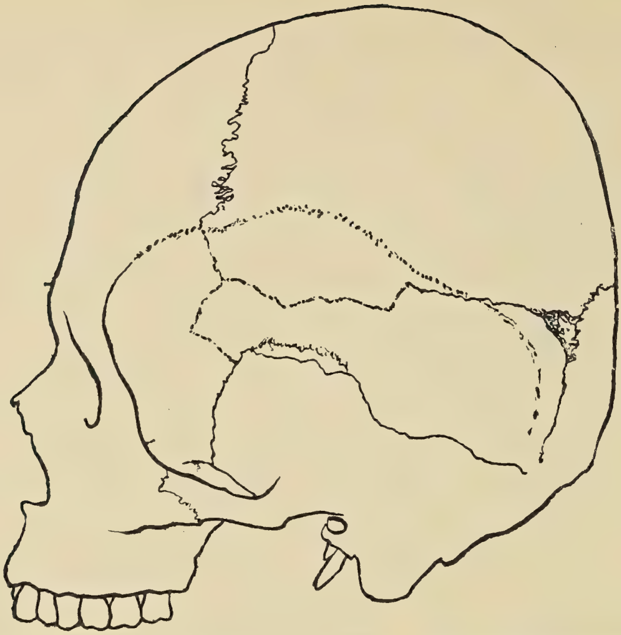


Fig. 10. Putnam's second case of parietal division. (Drawn from a photograph.)

Fig. 11. Putnam's second case of parietal division; the occipital borders of the parietals.

The division begins posteriorly 2.3 cm. above the asterion and passes at first upward, then forward and slightly downward to the squamous suture. It separates a five-sided portion of bone, which measures 5.5 cm. in its greatest length, and 4.0 cm. in its greatest height parallel to the lambdoid suture. Near the middle of the lambdoid suture is a moderate-sized intercalated bone (y), which may be of some importance; the signification of this ossicle will be referred to at the end of this section.

Surface Measurements of the Two Parietals:

		Left	Right
Temporo-sphenoidal point to anomalous suture		2.2 cm.	—
do.	to bregma	14.5 "	13.1 cm.
Infero-superior at middle	to anomalous suture	3.0 "	"
	total	16.0 "	14.3 "
Asterion to lambda	to lower boundary of cleft	2.0 "	to suture 2.3 cm.
	to upper " " "	5.5 "	
	to lambda	109 "	to lambda 11.5 "
Antero-posteriorly at middle		14.2 "	about 14.0 "

The chief of these additional facts is the possibility of tracing the left division in the second case to, or at least very near to, the coronal suture. The case is one of a complete antero-posterior parietal division, and it would be erroneous to class it, as Ranke has done, on the basis of the original data, among the separations of the mastoid angle. The coexistence of an infero-posterior suture on the right with the antero-posterior one on the left side imparts to the case a considerable additional interest.

The *partial parietal divisions* in man which I have found comprise the following:

Case *a*. A calvarium of an adult male skull, No. 1003, Medical Department, Columbia University,[1] N. Y.

The calvarium comprises most of the frontal squama and about the anterior ¾ of each parietal. No abnormalities. Advancing synostosis in both the sagittal and coronal sutures.

The anterior portion of the right parietal shows an incomplete division. This begins at the summit of a 0.5 cm. deep cleft in the anterior border of the bone, at the level of the

[1] Prof. Geo. S. Huntington's Morphological Museum.

superior line of the temporal ridge, and runs for 1.7 cm. closely to this line in a backward and upward direction. The division was somewhat serrated; externally it shows an advanced, internally a complete occlusion. There are traces of a more vertical suture that probably connected with the antero-posterior one between the third and median fourth of the latter, and bounded a large Wormian or fontanel bone situated in the coronal suture. On the left side there is in the anterior border of the parietal a 0.7 cm. deep cleft, located a little above the temporal ridge, but no trace of any division.

Cases *b*, *c*, *d*. Skull of an adult white, sex uncertain; No. 1002, M. D., C. U., N. Y.

Calvarium somewhat asymmetrical; a broad, shallow depression posteriorly to the coronal suture, and a somewhat abnormal elevation of the sagittal region at vertex. A large epactal bone, with a moderate-sized separate bone above it in lambda. Synostosis of the sagittal suture about obelion.

The left parietal bone shows in its anterior portion a 0.6 cm. long, straight, slightly serrated incisure. The division starts from the coronal suture between the two lines of the temporal ridge, 6.7 cm. below the bregma, and is directed backward and slightly upward. There is a trace of a similar incisure in the same location on the right parietal.

Two other calvaria showed similar short divisions situated between (2), or a slight distance above (1) the temporal lines.

Case *e*. Skull of a female, Swiss, 65 years old; No. 613, 1899–1900, M. D., C. U., N. Y.

Present only parts of the temporal, occipital, and right parietal bones.

The postero-inferior portion of the parietal bone shows a straight, slightly serrated, 1.3 cm. long, ventrally occluded division; the division begins in the posterior border of the parietal, 0.9 cm. above the asterion, and runs upward and forward, in the direction of the parietal eminence.

There are remnants of the suturæ mendosæ and the squamo-mastoid sutures.

Case *f*. Skull of a male white in advanced adult life (about 55 y.), No. 1067, M. D., C. U., N. Y.

The posterior portion of the left parietal bone shows remnants of an oblique division. This begins 0.7 above asterion and runs upward and forward toward the parietal eminence. The division can be plainly traced for 1.1 cm. externally, but is completely occluded ventrally.

The skull shows nothing pathological and no further anomalies.

Among the total of six cases in this category there are four with slight, more or less horizontal, anterior, and two with moderate, oblique, postero-inferior divisions of the parietal, all occurring in apparently normal adult skulls of whites.

New Instances of Anomalous Divisions of the Parietal Bones in Monkeys.

The total number of apes, monkeys, and lemurs examined by me for parietal divisions was 410, and of this there were:

Apes	Chimpanzee	2,	divisions found in	1
	Gorillæ	7	" " "	0
	Orangs	3	" " "	0
	Gibbons	2	" " "	0
		14	" " "	1
Old World Monkeys	Cynocephali	29	" " "	2
	Cercopitheci	43	" " "	1
	Chlororebi	3	" " "	0
	Cercocebi	7	" " "	0
	Colobus	1	" " "	0
	Macaci	190	" " "	32
		273	" " "	35
American Monkeys	Cebi	39	" " "	9
	Ateles	41	" " "	7
	Mycetes	2	" " "	0
	Alouatas	5	" " "	0
	Nyctipithecus	1	" " "	0
	Hapale	30	" " "	1
		118	" " "	17
Lemurs		5	" " "	0
Total		410	" " "	53

Of the 52 cases in monkeys there are 23 with but one complete or incomplete division in one of the parietals, the other bone showing no anomaly of this nature; in 1 instance there is more than one division in one parietal bone and none in the other; and in 28 cases there is one or more divisions in each parietal. In 9 of the 52 skulls there are co-existing partial divisions on one (7) or both sides (2) in the temporal squama, in line with, and looking like the extension of, the parietal suture.

In order to facilitate their description the new cases can be arranged, on the basis of the nature of the divisions, into several groups. These are:

(1) Partial vertical (infero-superior) divisions;
(2) Complete " " "
(3) Partial and complete vertical-oblique (sagittal to mastoid border) divisions;
(4) Partial and complete vertical sutures or fissures communicating with a temporal division;
(5) Partial and complete more or less horizontal (antero-posterior) divisions; and
(6) Compound cases. This last group includes some oblique divisions.

The cases in detail are as follows:

GROUP 2. PARTIAL VERTICAL (INFERO-SUPERIOR) DIVISIONS IN MONKEYS.

Case 1. *Cynocephalus baboon*, male, adolescent; No. 56, M. D., C. U., N. Y.

There is a 0.2 cm.-long vertical incisure in the sagittal portion of the left parietal bone, near its middle. Besides this the skull shows nothing special.

Case 2. *Macacus rhesus*, sex unknown, adolescent; No. 3775, A. M. N. H.,[1] N. Y.

There are plain traces of an occluded vertical division on the sagittal portion of each parietal. The divisions begin opposite each other, a little posterior to the anterior third of the sagittal border of each bone (1.6 cm. from bregma, 3.0

[1] Zoölogical Collection.

cm. from lambda), and both run straight downward, diverging slightly from the coronal suture. The left division can be traced for 1.8 cm., the right one 1.6 cm.

The skull is symmetrical and without other exceptional features. The parietal bones are almost equal in size.

Case 3. *Macacus rhesus*, male, adolescent; No. 3843, A. M. N. H., N. Y.

The sagittal portion of the right parietal bone is divided by a vertical fissure. The division begins very near the middle of the sagittal border (2.05 cm. from bregma, 2.0 cm. from lambda) and runs downward, parallel with the lambdoid suture. It is patent for 0.45 cm., but can be plainly traced 1.1 cm. further.

The skull is symmetrical and without other abnormalities. The right parietal is slightly lower over its anterior two thirds, but throughout, except at the sagittal border, appreciably longer, than the left.

Surface measurements of the two parietal bones:

Lower end of coronal suture to bregma	left	4.05,	right	4.0	cm.
Infero-superiorly at middle	"	4.2	"	4.0	"
Asterion-lambda	"	3.2	"	3.2	"
Lower end of coronal suture to asterion	"	4.6	"	4.75	"
Antero-posteriorly at middle	"	4.45	"	4.65	"

Case 4. *Macacus rhesus*, male, adolescent; No. 3, M. D., C. U., N. Y.

There is a 0.5 cm.-long straight incisure in the sagittal portion of the left parietal bone. The division begins somewhat anterior to the middle of the sagittal border (1.6 cm. from bregma, 2.2 cm. from lambda) and runs parallel to the coronal suture.

The skull is symmetrical, without any other remarkable features. The two parietals are almost exactly alike in measurements.

Case 5. *Macacus rhesus*, male, adolescent; No. 13, M. D., C. U., N. Y.

The sagittal portion of the left parietal bone shows a 0.95 cm. long, slightly serrated, straight division, running nearly

parallel with the lambdoid suture. The division begins between the middle and fourth fifth of the sagittal border of the bone (2.55 cm. from bregma, 1.7 cm. from lambda).

Fig. 12. *Macacus rhesus* (No. 3, Morphological Museum, Columbia University). Incisure in the sagittal border of the left parietal.

There is no trace of any division in the right parietal. The surface measurements of the two lower show the right parietal to be slightly longer, and in the anterior three fourths also appreciably higher than the left one.

The skull is fairly symmetrical. There is a small bregmatic bone. No signs of any injury.

Surface measurements of the two parietals:

Point of junction of squamous and coronal sutures to bregma	left	4.15,	right	4.2	cm.
Infero-superiorly at middle	"	4.2	"	4.45	"
Asterion to lambda	"	3.2	"	3.2	"
Squamo-coronal junction to asterion	"	4.7	"	4.75	"
Antero-posteriorly at middle	"	4.95	"	5.0	"

Case 6. *Macacus rhesus*, sex unknown, adolescent; No. 106, M. D., C. U., N. Y.

The left parietal shows a 1.2 cm.-long mark of a vertical division, running from the sagittal border, parallel to the coronal suture. The division began slightly anterior to the middle of the border (1.8 cm. from bregma, 2.1 cm from lambda).

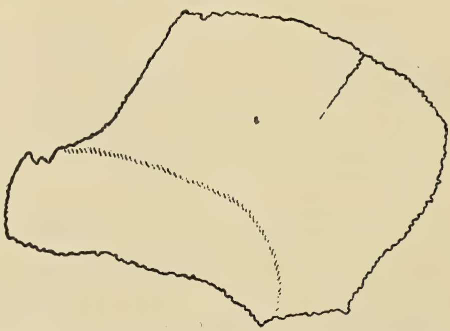


Fig. 13. *Macacus rhesus* (No. 13, Morphological Museum, Columbia University). Partial vertical division of the left parietal.

Skull symmetrical, no injuries or other anomalies. The left parietal is slightly shorter inferiorly, but slightly longer above the lowest third, than the right, the height of both bones being very nearly equal.

Surface measurements of the two parietal bones:

Lower end of coronal suture to bregma	left	4.5,	right	4.5 cm.
Infero-superiorly at middle	"	4.3	"	4.35 "
Asterion to lambda	"	3.2	"	3.2 "
Lower end of coronal suture to asterion	"	4.6	"	4.75 "
Antero-posteriorly at middle	"	4.95	"	4.8 "

Case 7. *Macacus rhesus*, female, young adolescent; No. 111, M. D., C. U., N. Y.

The parietal bones show each a vertical, straight, almost entirely occluded division in their superior portion. The division on left begins in the sagittal border of the parietal, 2.45 cm. from the bregma and 1.85 cm. from the lambda, that on right 2.7 cm. from the bregma and 1.6 cm. from the lambda. Both run almost parallel to the coronal suture. The division in the left parietal can be plainly traced for 2.3 cm., that in the right for 1.1 cm.

The skull shows no injuries or other gross anomalies. The two parietals are almost identical in measurements.

Case 8. *Macacus rhesus*, male, adolescent; No. 120, M. D., C. U., N. Y.

There is a partial vertical division in the sagittal portion of the left parietal bone. The division begins slightly posterior to the anterior third of the sagittal border (1.6 cm. from bregma, 2.4 cm. from lambda). It is 0.55 cm. long, but can be traced, particularly by transmitted light, 1.0 cm. further; it is straight, not serrated or squamous, and runs downward, diverging slightly from the coronal suture.

There is no trace of any division on the right parietal. The skull is symmetrical and without other gross anomalies. No sign of any injury. The surface measurements of the two parietals are very nearly equal.

Case 9. *Macacus rhesus*, sex unknown, young; No. 134, M. D., C. U., N. Y.

The right parietal shows a plain trace of a vertical division,

running from the sagittal border of the bone to near the temporal ridge. It begins 1.65 cm. posterior to the bregma and 2.65 cm. from the lambda, and runs nearly parallel with the coronal suture. The skull is symmetrical, the parietals of very nearly the same size.

Case 10. *Macacus rhesus*, sex unknown, adolescent; No. 137, M. D., C. U., N. Y.

There are traces of a vertical division in the superior portion of each parietal. Both divisions begin posterior to the middle of the sagittal border, that on left 2.45 cm. from bregma and 1.65 cm. from lambda; that on right 2.95 cm. from bregma and 1.15 cm. from lambda. The sagittal extremity of both is still open. The division on the left can be traced for 1.1 cm., that on the right for 1.7 cm. Both are straight and nearly parallel with the lambdoid suture.

The measurements show that the anterior two thirds of the right parietal are slightly higher, while the length of the two bones is very nearly the same.

The frontal bone shows on left, near the eminence, a 1.3 cm.-long, 0.9 cm.-broad, and 0.25 cm.-deep depression, and in the floor of this are two small oval perforations. There are no signs of fracture or inflammation, and the origin of the depression is not clear. It stands in no perceivable connection with the parietal divisions.

Case 11. *Macacus rhesus*, sex unknown, adolescent; No. 148, M. D., C. U., N. Y.

The right parietal shows a 2.4 cm.-long mark of a vertical division, which begins in the middle of its sagittal border and runs downward parallel with the coronal suture.

The skull is fairly symmetrical; there are no injuries or other anomalies. The skull being open the parietals cannot be properly measured.

Case 12. *Macacus cynomolgus*, female, adolescent; No. 122, M. D., C. U., N. Y.

The left parietal bone shows near its middle traces of what was probably originally a complete anomalous parietal division. The skull is symmetrical and without further anomalies.

Case 13. *Macacus erythræus*, sex unknown, adolescent; No. 1613, A. M. N. H., N. Y.

The sagittal portion of each parietal bone shows a vertical division.

The division on the left begins superiorly almost at the middle of the sagittal border of the parietal (2.2 cm. from bregma, 2.1 cm. from lambda), is 0.4 cm. long, straight, and parallel with the lambdoid suture. The division on the right begins sagittally near the posterior fourth of the border, passes for 0.45 cm. downward nearly parallel with the lambdoid suture, then becomes considerably occluded, but can be followed 0.8 cm. further, running downward and somewhat forward, in the direction of the parietal eminence.

The skull is symmetrical, the parietals nearly equal. No injuries or other anomalies.

Case 14. *Macacus erythræus*, sex unknown, adolescent; No. 4347, A. M. N. H., N. Y.

The right parietal bone shows a short vertical incisure between the middle and posterior thirds of its sagittal border. From this incisure a plain mark of an occluded division runs downward, parallel with the lambdoid suture, to the temporal ridge (3.2 cm. from the sagittal, 1.0 cm. from the squamous suture).

The skull is symmetrical and free from signs of injuries and other anomalies. The right parietal bone is somewhat higher, but at middle a little shorter than the left one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma	left 4.1,	right 4.3	cm.
Infero-superiorly at middle	" 4.05	" 4.2	"
Asterion to lambda	" 2.85	" 2.95	"
Squamo-coronal junction to asterion	" 4.7	" 4.7	"
Antero-posteriorly at middle	" 4.7	" 4.6	"

Case 15. *Cebus*, sex unknown, young; No. 86, M. D., C. U., N. Y.

The superior part of the anterior portion of the left parietal bone shows one, and the sagittal portions of both the left and right parietal each two marked clefts.

The anterior division on left is 0.4 cm. long and directed

downward and backward. The more anterior of the left sagittal clefts begins superiorly nearly at the middle of the border, is 1.1 cm. long, and runs downward and slightly forward. The second left sagittal cleft begins between the third and last fourths of the border, is 0.35 cm. long and is also directed downward and slightly forward.

On the right side, the more anterior of the two clefts begins 0.3 cm. posteriorly to the bregma, is 0.4 cm. long, and runs nearly parallel with the coronal suture, showing a slight tendency to turn backward. The more posterior cleft on this side begins superiorly between the middle and last thirds of the sagittal border, is 0.6 cm. long, and passes downward with a tendency to curve backward. (Pl. IX.)

The skull is fairly symmetrical and free from other anomalies.

Case 16. *Ateles ater*, young, sex unknown; No. 187, M. D., C. U., N. Y.

The sagittal portion of the left parietal shows a partly occluded 1.0 cm.-long division, running parallel with the lambdoid suture.

The skull is symmetrical; the right parietal bone is both slightly longer and broader than the left one.

Case 17. *Hapale*, sex unknown, young; No. 58*a*, M. D., C. U., N. Y.

The right parietal bone shows a remnant of, in all probability, a formerly complete vertical-horizontal suture. The remaining part of the division begins distally in the sagittal border of the parietal, 0.3 cm. anteriorly to the lambda. It runs with several bends and curves downward and forward over the eminence and to near the temporal ridge, where it becomes totally occluded.

Fig. 14. *Hapale* (No. 58*a*, Morphological Museum, Columbia University). Division of right parietal.

The skull shows no other special features. The right parie-

tal bone is very slightly longer, and a little lower than the left one.

GROUP 3. COMPLETE VERTICAL PARIETAL DIVISIONS IN MONKEYS.

Case 18. *Macacus rhesus*, male, advanced adolescent; No. 10, M. D., C. U., N. Y.

The parietal bones show each a vertical division.

The division in the left parietal begins slightly anterior to the point between the most anterior and middle thirds of the sagittal border of the bone (1.6 cm. posterior to the bregma, 3.6 cm. anterior to the lambda). It runs in a slightly wavy course downward and a little backward to the upper boundary of the temporal ridge, beyond which no marks of any further division are visible. Below its superior two fifths the division shows advancing occlusion.

The right parietal bone shows a superior and an inferior fissure, but these two are joined by a plainly traceable line of occlusion; it is evident that originally the bone was separated into two by a complete vertical suture. The division began superiorly between the middle and posterior third of the sagittal border (3.2 cm. from bregma, 2.0 cm. from lambda) and ran parallel with the lambdoid suture. The inferior open segment reaches the lower boundary of the temporal ridge.

The normal sutures are still all patent. The anomalous sutures were, so far as can be seen in their remnants, of a very slightly squamous nature, the border of the anterior overlapping those of the posterior portions.

The skull is symmetrical and the two parietals differ but insignificantly in size, as can be seen from the following surface measurements:

Junction of squamous and coronal sutures to bregma	left 4.4,	right 4.45	cm.
Junction of squamous and coronal sutures to asterion	" 4.8	" 4.85	"
Asterion to lambda	" 3.35	" 3.3	"
Antero-posteriorly at middle	" 5.4	" 5.3	"
Infero-superiorly " "	" 4.65	" 4.6	"

The same skull shows, without any sign of an injury in any part, a separation of a portion of the lower border of the nasal bones, and two supranasal ossicles. (Fig. 15 and Pl. VII.)

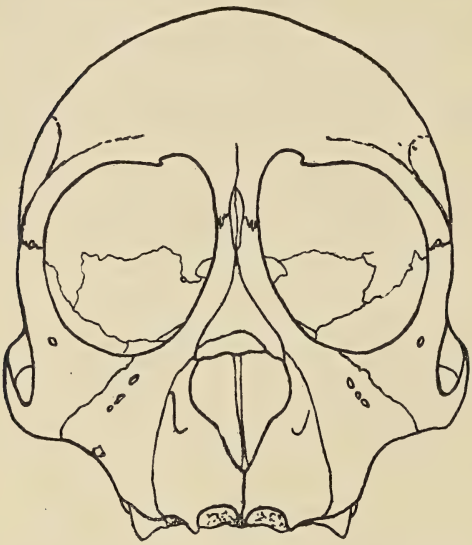


Fig. 15. *Macacus rhesus* (No. 10, Morphological Museum, Columbia University). Showing a separation of the lower portion of the nasal bones, and two independent supranasal ossicles.

Case 19. *Macacus cynomolgus*, sex ?, nearly adult; No. 38, M. D., C. U., N. Y.

The cranium presents well-marked traces of a complete vertical division of the right parietal.

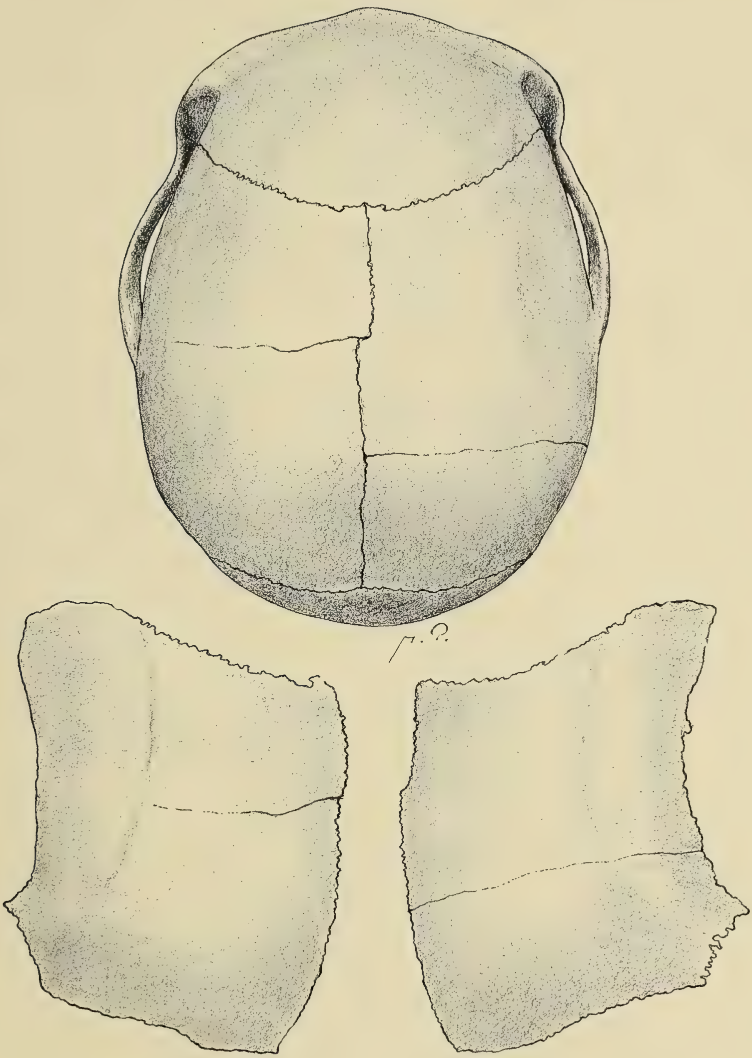
The anomalous suture consists of a superior, open, 7 mm.-long extremity, which begins slightly posteriorly to the middle of the sagittal border of the right parietal, and runs almost parallel with the vertical axis of the bone; and of an obliterated, but traceable part, which proceeds from the open extremity downward, in the same direction, to the temporal border of the parietal. Eleven mm. from the sagittal border a small open slit is seen in the course of the division.

Measurements of the two parietal bones:

Length in middle	left	5.05,	right	5.4	cm.
" squamo-coronal point to asterion	"	4.45	"	4.5	"
Hight, " " " " bregma	"	4.1	"	4.25	"
" in middle	"	4.15	"	4.15	"
" asterion to lambda	"	3.0	"	3.0	"

The right bone is throughout larger antero-posteriorly, and is also slightly higher in front than the left.

The skull as a whole is not perceptibly asymmetrical, shows



L. R.

Macacus rhesus, Male (No. 10, Morphological Museum, Columbia University). Vertical, partly obliterated, Parietal Divisions.

no signs of injuries and no further anomalies. All the normal sutures are open and there are no Wormians.

Case 20. *Macacus rhesus*, young adolescent, sex unknown. No. 101, M. D., C. U., N. Y.

The right parietal shows two extremities of a vertical suture, connected by traces of the same.

The superior end of the division begins 2.4 cm. posterior to bregma, 2.1 cm. anterior to lambda, is straight, and 0.4 cm. long. The lower end, nicely serrated, is 0.7 cm. in length. The intervening traces of the complete suture show that this was of a nearly straight course and ran parallel to the lambdoid suture, crossing the parietal eminence. The eminence is somewhat rough and irregular.

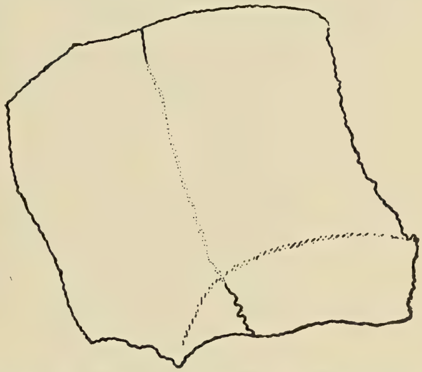


Fig. 16. *Macacus rhesus* (No. 101, Morphological Museum, Columbia University). Vertical, partly obliterated, parietal division.

Surface measurements of the two parietals show that the divided bone is slightly longer than the one on the opposite side:

Bregma to lambda	left 4.3,	right 4.5	cm.
Temporo-sphenoidal junction to bregma	" 4.4	" 4.5	"
" " " to asterion	" 4.2	" 4.2	"
Asterion to lambda	" 3.4	" 3.5	"
Antero-posteriorly at middle	" 4.55	" 4.8	"
Infero-superiorly " "	" 4.4	" 4.35	"

The skull is fairly symmetrical and without further anomalies.

GROUP 4. VERTICAL-OBLIQUE PARIETAL DIVISIONS IN MONKEYS.

Case 21. *Macacus rhesus*, female, adolescent; No. 37, M. D., C. U., N. Y.

Both parietals show remnants of a vertical-oblique division, which began superiorly in the sagittal border of each bone, 2.0 cm. from bregma and 2.4 cm. from lambda, and ended on each side in or near the mastoid angle. The division on the left is partly, that on the right entirely, occluded. Both divisions ran nearly parallel with the coronal suture up to the parietal eminence, but began to curve backward between this and the temporal ridges. The deflection is most marked in the neighborhood of the ridges. The unoccluded portion of the left division shows it to have been of a slightly squamous nature, the border of the anterior portion of the parietal overlapping that of the posterior. (Pl. VIII.)

The skull is fairly symmetrical, without other anomalies and without any signs of injury. The right parietal bone exceeds the left slightly in all the measurements.

Surface measurements of the parietals:

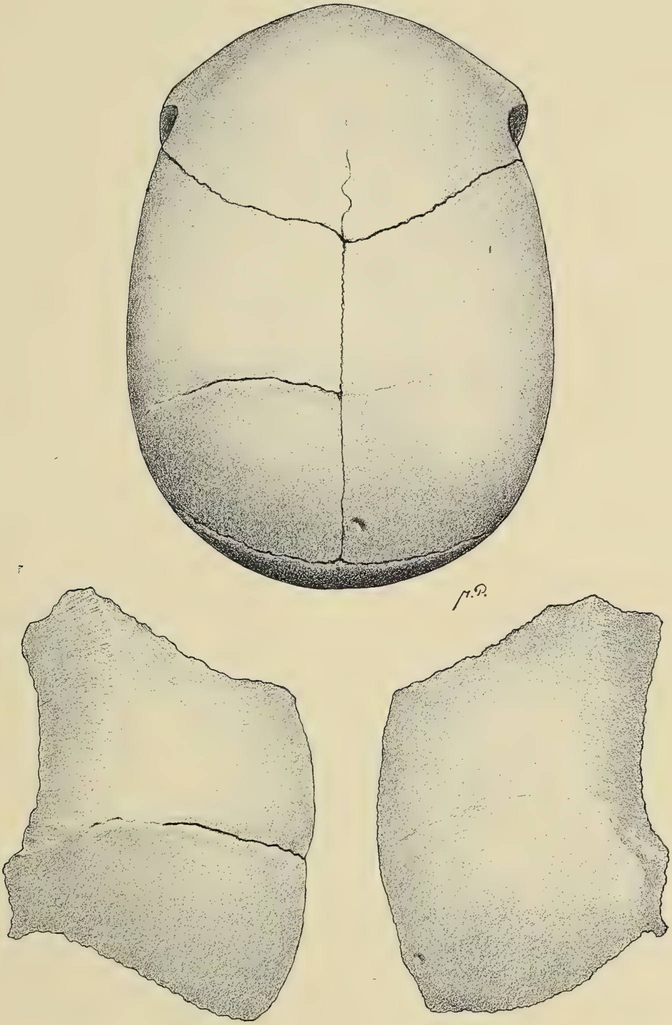
Lower end of the coronal suture to bregma...	left	4.0,	right	4.1	cm.
Infero-superiorly at middle.................	"	4.15	"	4.3	"
Asterion to lambda..........................	"	3.2	"	3.3	"
Lower end of the coronal suture to asterion...	"	4.15	"	4.35	"
Antero-posteriorly at middle................	"	4.8	"	5.1	"

Case 22. *Macacus rhesus*, young, sex unknown; No. 47, M. D., C. U., N. Y.

The specimen presents a division of the right parietal bone by a complete vertical-oblique suture, and traces of a similar division on the left parietal.

The right anomalous division begins superiorly on the sagittal border of the parietal, 1.7 cm. posterior to the bregma and 2.5 cm. anterior to the lambda. It runs in a slightly wavy course for 1.8 cm. parallel to the vertical axis of the bone, then bends in a broad curve backward, and proceeding backward and downward terminates, after making a small loop, at the beginning of the parieto-mastoid border. The whole suture is patent, and of the squamous character, the anterior division of the bone overlapping the posterior. In the terminal 5 mm. of the suture the border of the overlapping anterior portion shows a well-marked serration.

On the sagittal border of the left parietal, 0.85 cm. pos-



MACACUS RHESUS (NO. 37, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). PARIETAL DIVISIONS (RIGHT NEARLY OBLITERATED).

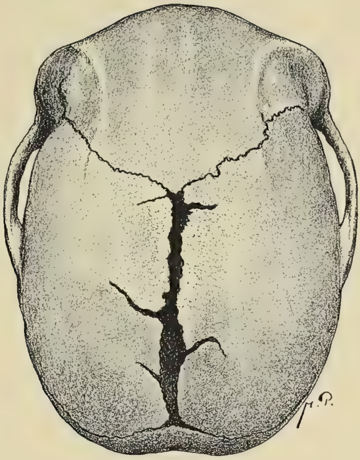


FIG. 1.

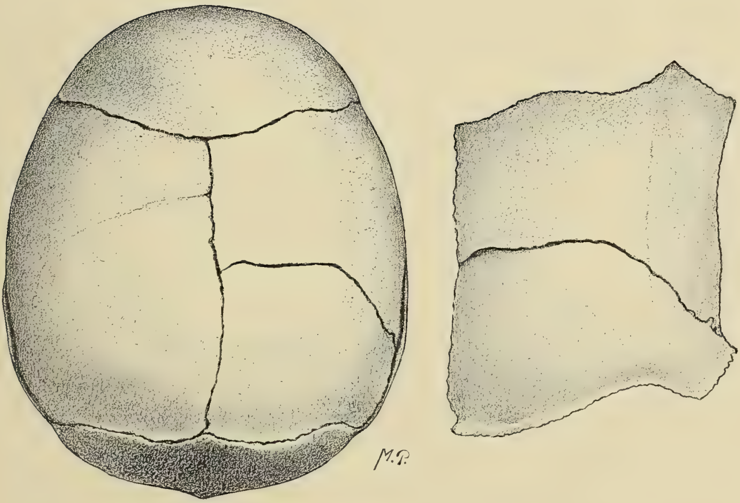


FIG. 2.

FIG. 1.—CEBUS, YOUNG (NO. 86, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). PARIETAL INCISURES.

FIG. 2.—MACACUS RHESUS (NO. 47, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). SHOWING PARIETAL DIVISIONS.

teriorly to the bregma, we find a trace of obliterated division which may be followed, with some difficulty, downward and backward, to near the beginning of the parieto-mastoid border. The border of the anterior portion of the bone along the upper part of this scar-like mark is elevated into a distinct ridge. (Pl. IX.)

The skull shows no signs of injuries and no anomalies besides the parietal divisions. All the ordinary cranial sutures are patent. There are no Wormian bones. The border of the occipital squama projects, on an average, about 1 mm. above the plane of the parietals (a condition quite common in macaques).

The two parietals show the following proportion (surface measurements):

Length along sagittal suture	left 4.2,	right 4.2	cm.
Squamo-sphenoidal point to asterion	" 4.25	" 4.25	"
" " " " bregma	" 3.9	" 4.05	"
Hight in middle	" 4.3	" 4.0	"
Asterion to lambda	" 2.95	" 3.1	"

The length of the two bones is about the same. In hight the right parietal predominates anteriorly and posteriorly, the left parietal in the middle.

Case 23. *Macacus rhesus*, male, young adolescent; No. 118, M. D., C. U., N. Y.

The skull presents a considerably occluded, vertical-oblique division of the right parietal bone, and a trace of a similar division on the left parietal.

The right anomalous division begins superiorly almost exactly in the middle of the sagittal border of the parietal. It proceeds for 3.2 cm. in a straight course and parallel to the lambdoid suture, to the temporal lines, then curves and runs backward and downward across the lines, and in an irregular course to the mastoid angle. The suture is distinct, but entirely occluded, with the exception of two small segments just above and below the temporal ridge. On the ventral surface of the bone the whole division is represented by a distinct, though shallow and narrow groove.

The external surface of the left parietal bone shows traces

of an occluded division, which began directly opposite the division on the right, ran vertically for nearly 2 cm., then curved backward and ran backward and downward. It can be traced to within 1 cm. of the asterion. This division is much less distinct than that on the right, and is not marked internally. Along the vertical part of the same, the border of the anterior portion of the parietal is elevated above that of the posterior.

Measurements of the two parietals:

Length along sagittal border	left 4.7,	right 4.7	cm.
" squamo-coronal to squamo-lambdoid point	" 5.05	" 5.15	"
Hight, squamo-coronal point to bregma	" 4.7	" 4.5	"
" in middle of the bone	" 4.6	" 4.6	"
" squamo-lambdoid point to lambda	" 2.85	" 2.8	"

Fig. 17. *Macacus rhesus* (No. 118, Morphological Museum, Columbia University). Vertical-oblique parietal division.

The two bones differ slightly in individual measurements, but their area, which may be represented by an average of all the measurements taken on each bone, is almost equal. The inequalities do not affect the symmetry of the skull, which shows no further anomalies, save a small Wormian bone in bregma, and no signs of injuries. All the normal cranial sutures are open.

GROUP 5. VERTICAL PARIETAL DIVISIONS WITH EXTENSION INTO THE TEMPORAL SQUAMA, IN MONKEYS.

Case 24. *Macacus rhesus*, female, adolescent; No. 15711, A. M. N. H., N. Y.

The right parietal bone shows a partial vertical division affecting its inferior portion, and this division connects ex-

ternally with an incisure in the temporal squama, running in the same direction.

The parietal division can be traced but 0.35 cm. above the squamous suture, which it meets at a point very near the middle between the squamo-lambdoid and squamo-coronal junctions.

The temporal fissure runs from a point very slightly anterior to that at which the parietal division reaches the squamous suture for 0.35 cm. straight downward, then makes two little loops backward, and ends in the upper portion of the depression above the base of the zygoma.

The skull is fairly symmetrical and shows no signs of any injury or any other anomalies. The right parietal bone is al-

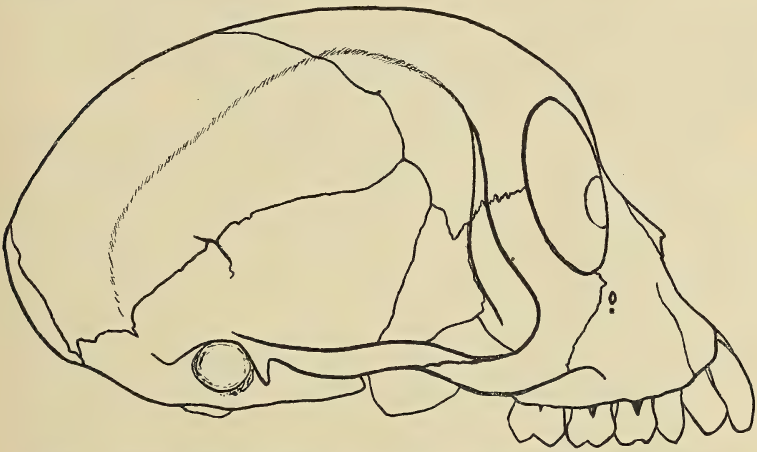


Fig. 18. *Macacus rhesus* (No. 15711, A. M. N. H.). Partial temporo-parietal division.

most throughout its whole extent longer and anteriorly quite considerably higher, but posteriorly lower, than the left one.

Surface measurements of the two parietals:

Hight, squamo-coronal junction to bregma. . .	left 3.95,	right 4.5	cm.
" infero-superiorly at middle.	" 4.2	" 4.2	"
" asterion to lambda.	" 3.5	" 3.2	"
Length, squamo-coronal junction to asterion. .	" 5.0	" 5.0	"
" 0.5 cm. above squamo-coronal junction and asterion.	" 5.0	" 5.1	"
" in middle.	" 4.35	" 4.5	"
" along sagittal suture.	" 3.45	" 3.65	"

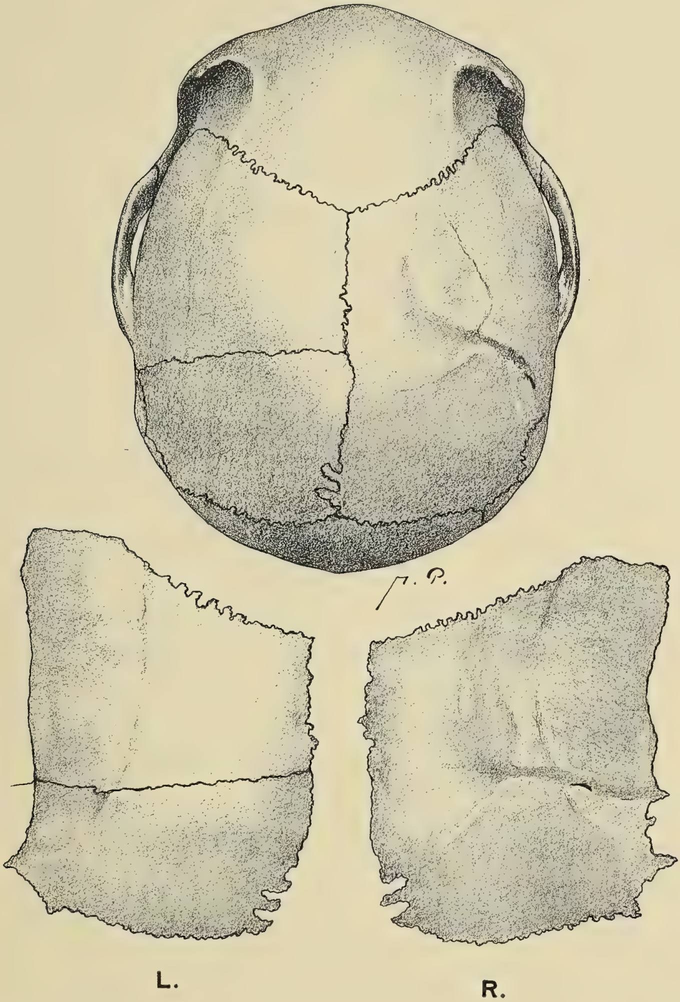
Case 25. *Macacus rhesus*, female, adolescent; No. 14, M. D., C. U., N. Y.

The left parietal bone shows a complete, the right a partly obliterated, vertical parietal division, and both these divisions are externally slightly prolonged downward by a fissure in each temporal squama.

The division in the left parietal begins superiorly in the sagittal border of the bone, 1.7 cm. from bregma and 2.1 cm. from lambda, and runs in a nearly straight course, converging slightly from above downward with the lambdoid suture, to a point on the squamous suture distant 3.0 cm. from the squamo-coronal junction and 1.8 cm. from the asterion. At this point the division is met by the 0.35 cm.-long temporal incisure, which runs downward in the same direction with the parietal suture. The anomalous division is slightly squamous in character, the border of the anterior overlapping that of the posterior portion of the bone.

The division in the right parietal begins inferiorly directly above a 0.2 cm.-long vertical fissure in the temporal squama, at a point distant 3.0 cm. from the squamo-coronal junction and 1.8 cm. from asterion. The parietal division soon becomes occluded, but can be easily followed upward, as a quite broad mark, to the sagittal fourth of the bone, where it curves forward and becomes indistinct. One centimeter above the squamous suture there is in the just-mentioned mark a second, short, patent segment of the division; while 2.1 cm. above the squamous suture there diverge from the mark two moderate elevations. The anterior of these elevations runs in a slightly wavy course to within a short distance from the superior fourth of the coronal; the posterior, in a similar course, to within a short distance from the posterior fourth of the sagittal suture. The part of the parietal bone immediately above these elevations is slightly depressed. It appears as if the elevations and the depression above them represented the borders of inferior and superior portions of the parietal bone, separated formerly by now occluded divisions. (Pl. X.)

Neither the right parietal bone nor any other part of the



Macacus rhesus, Female (No. 14, Morphological Museum, Columbia University). Bilateral Vertical Parietal Division, extending on each side slightly into the Temporal Squama. The suture in the right Parietal is nearly obliterated.

skull shows any signs of violence or any pathological condition. Judging from this fact and the symmetry of the inferior part of the division on the right to that on the left side, it is probable that the marks on the right parietal are remnants of anomalous divisions of the bone. The divisions superior to the parietal eminence must have become occluded very early, and the direction of the marks may have been modified somewhat by an unequal growth of the various portions of the bone.

The parietal region of the skull is slightly asymmetrical. The right parietal bone is throughout somewhat higher and at middle also slightly longer than the left one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma..........	left	4.2,	right	4.5	cm.
Infero-superiorly at middle..................	"	4.0	"	4.15	"
Asterion to lambda.........................	"	2.7	"	2.9	"
Squamo-coronal junction to asterion..........	"	4.8	"	4.8	"
Antero-posteriorly at middle.................	"	4.8	"	4.95	"

Case 26. *Macacus rhesus*, sex unknown, adolescent; No. 107, M. D., C. U., N. Y.

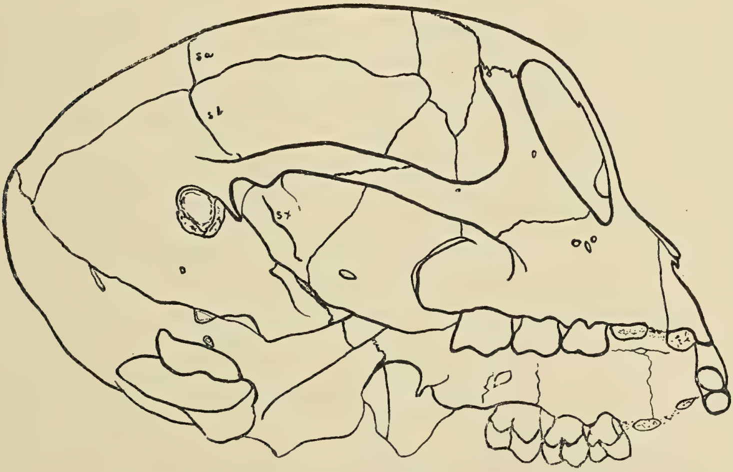


Fig. 19. *Macacus rhesus* (No. 107, Morphological Museum, Columbia University). Temporo-parietal division.

The inferior portion of the right parietal bone is separated by a vertical division, and this is met at the squamous suture

by a division in the temporal bone, running in the same direction.

The parietal division is patent from the inferior border of the bone to 1.4 cm. above the squamous suture, which it meets nearly at the middle point between asterion and the squamo-coronal junction. The course is upward and slightly forward; it reaches the lower boundary of the temporal ridge, beyond which it is not traceable. The superior 0.4 cm. of the division shows several points of occlusion.

The temporal division begins slightly posterior to the point at which that of the parietal meets the squamous suture and runs downward to above the base of the zygoma, where externally it becomes obliterated. Slightly below and anteriorly to the end of the superior division another fissure begins and runs for about 0.6 cm. through the zygomatic fossa and along the middle of the base of the zygoma. Upon examining the right glenoid fossa, we find that anterior to the Glasserian fissure the fossa is traversed by still another slightly wavy, 1.05 cm. long division, which begins on the basal surface of the zygoma and ends before reaching the median border of the temporal bone. The superior and this basal temporal division run in nearly the same line.

The very unusual condition just described is explained when we remove the parietal bones and examine the skull ventrally. It is then seen that the superior divisions, as well as that in the glenoid fossa, penetrate the bone and form on the inside of the skull parts of a slightly serrated suture, which runs from the superior border of the squama downward and inward to and over the border of the basilar portion of the temporal bone anterior to the Glasserian fissure, and connects with the basilar extremity of the temporo-sphenoidal suture. There are a few small points of obliteration in the basal end of this anomalous division.

The skull shows absolutely no sign of any injury, or any sign of restitution (porosity or new bone formation) along the temporal or parietal divisions. The skull is symmetrical and free from other anomalies. The right parietal bone is longer and slightly higher, and the right temporal squama is equally

slightly longer and higher than the same parts on the left side.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma	left 4.3,	right 4.5	cm.
Infero-superiorly at middle	" 4.75	" 4.8	"
Asterion to lambda	" 3.2	" 3.2	"
Squamo-coronal junction to asterion	" 4.9	" 5.1	"
Antero-posteriorly at middle	" 4.15	" 4.3	"

The exact nature of the parieto-temporal division in this case must remain somewhat uncertain until large numbers of other specimens have been reported upon. There are factors, such as the absence of injury and signs of restitutive processes; the involvement of the whole temporal bone ventrally, while there are interruptions externally; the signs of occlusion at the extremities of the division; the beginning of the temporal division at a little distance from the point at which the parietal division reaches the temporal squama and in a notch, which was observed in all other cases of parieto-temporal division; and the similarity of location of the divisions with that in cases where there is no doubt as to the anomalous nature of the divisions; all of which favor more or less the assumption that in this case, also, we have examples of anomalies. What creates doubt as to this conclusion are the unusual location of the temporal division and another fact, not yet mentioned: when we separate the edges of the divided bones, we see that in parts of both the parietal and temporal bones the borders do not show articular surfaces, but an open cellular structure.

Case 27. *Macacus*, species and sex unknown, adolescent; No. 11022, A. M. N. H., N. Y.

The specimen presents on each side an anterior episquamous bone, which, as comparison with other macaque skulls shows, is either formed at the expense of, or, (more probably) is a separation, of the extremity of the sphenoidal angle of each parietal; and there are two incisures, one on each side, in the superior portion of the temporal squama, one connecting with, and the other in the neighborhood of, the suture that bounds superiorly the separate ossicles.

The separate bones are triangular in shape. The one on

the left measures 0.3 cm. along the coronal and 0.5 cm. along the squamous suture; that on the right is slightly larger.

The temporal incisure on the left is 0.7 cm., that on the right 0.4 cm. long. The left incisure runs parallel with the temporo-sphenoidal suture; that on the right side passes vertically downward, but at its end makes a slight curve forward and would end, if prolonged, in the upper portion of the sphenoidal portion of the temporal.

Posterior to the beginning of the left temporal incisure the squamous suture turns downward and runs to the extremity of the division, thus forming a deep notch, and leaving uncovered a narrow strip of the subsquamous portion of the parietal bone. This condition shows that the incisure is not recent. (Pl. XI.)

Ventrally, the conditions are almost the same as externally; the separate bones have all the appearance of being portions of the parietal bone.

The skull shows no signs of any injury or any pathological condition. It is symmetrical, and, with the exception of an oblong ossicle between the left nasal bone and superior maxilla, is free from further anomalies.

Surface measurements of the two parietals show the left bones to be inferiorly slightly longer, while superiorly the condition is reversed, the right bone being very slightly the longer.

Hight,	lower end of the coronal-suture to bregma	left	4.3,	right	4.3	cm.
"	infero-superiorly at middle	"	3.8	"	3.8	"
"	asterion to lambda	"	2.2	"	2.15	"
Length,	lower end of coronal suture to asterion	"	4.45	"	4.25	"
"	antero-posteriorly at middle	"	4.7	"	4.7	"
"	bregma to lambda	"	3.45	"	3.55	"

Case 28. *Cebus albifrons*, male, nearly adult; No. 8309, A. M. N. H., N. Y.

The inferior portion of the right parietal bone shows, near its middle, a vertical division, and this is met externally by a partial division in the temporal squama running in the same direction.

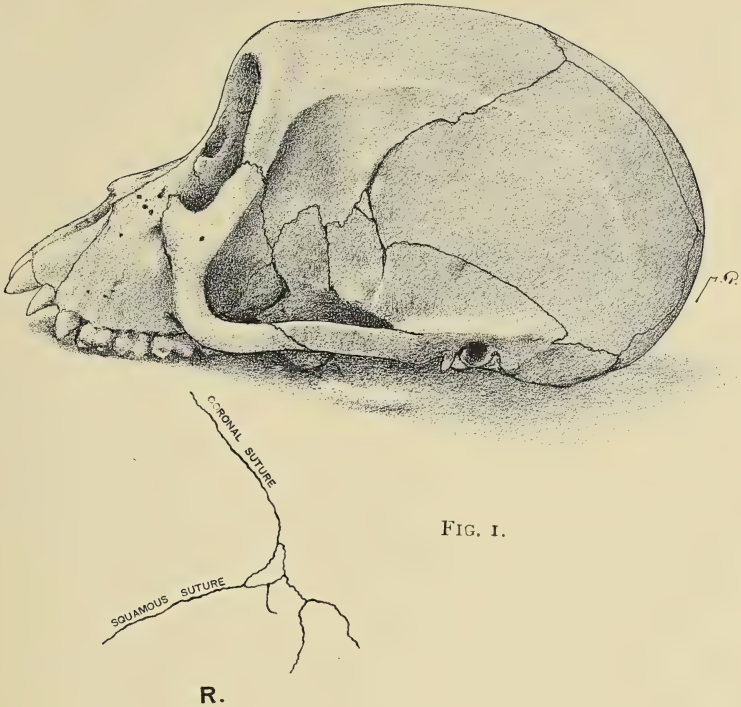


FIG. 1.

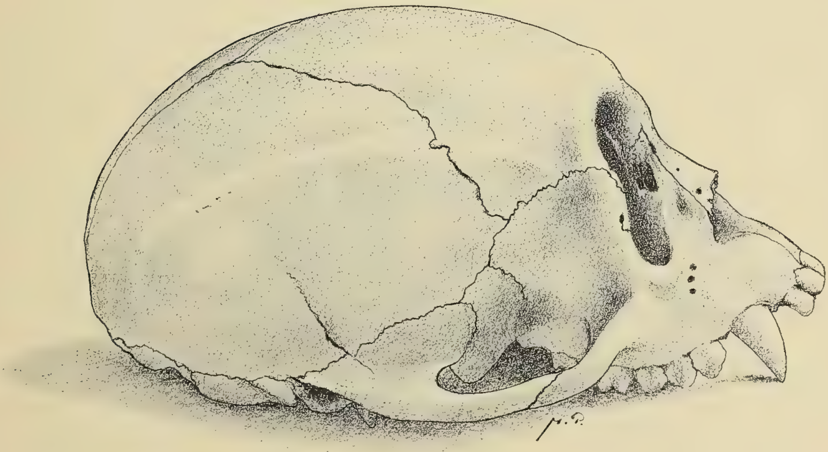


FIG. 2.

FIG. 1.—MACACUS (NO. 11,022, A. M. N. H.) BILATERAL SEPARATION OF THE TIP OF THE SPHENOIDAL PROCESS OF THE PARIETAL; EXTENSION OF THE DIVISION INTO THE TEMPORAL.

FIG. 2.—CEBUS ALBIFRONS (NO. 8309, A. M. N. H.). PARIETO-TEMPORAL DIVISION.

The parietal division begins inferiorly in the border of the bone and runs upward, with a few serrations, parallel with the coronal suture. It is patent from the border of the parietal to 0.6 cm. above the external line of the squamous suture, but can be traced 0.8 cm. further upward.

The temporal fissure begins superiorly in a notch in the border of the squamous portion, situated slightly anterior to the point at which the parietal division meets the squamous suture. It is 0.5 cm. long, but probably a part of its inferior extremity is obliterated. The division is nearly straight and ends in the upper part of the fossa above the base of the zygoma. (Pl. XI.)

The skull shows no signs of any injury or other anomalies, and is symmetrical. The right parietal bone is longer and at middle higher, but posteriorly slightly lower than the left one.

Surface measurements of the two parietals:

Junction of coronal and fronto-malar sutures to bregma	left	5.0,	right	5.0	cm.
Infero-superiorly at middle	"	5.15	"	5.4	"
Asterion to lambda	"	3.45	"	3.3	"
Junction of coronal and fronto-malar sutures to asterion	"	4.6	"	4.75	"
Antero-posteriorly at middle	"	5.5	"	5.7	"

Case 29. *Cebus hypoleucus*, sex unknown, adolescent; No. 10720, A. M. N. H., N. Y.

There is a vertical division in the left parietal, extending from the inferior border of the bone to the temporal ridge; and a temporal division, following directly in the course of the parietal one and ending in the fossa above the base of the zygoma.

Externally both divisions begin at the squamous suture, at a point slightly anterior to the middle between the lower end of the coronal suture and the asterion. Their course is almost parallel with that of the coronal suture. The total external length of the parietal division is 1.9 cm., that of the temporal 0.6 cm. The parietal division shows considerable occlusion advancing from above; the inferior extremity of the temporal fissure shows also some occlusion. (Pl. XII.)

The skull is symmetrical. There are no signs of any injury or other anomalies. The left parietal bone is inferiorly very slightly longer, at middle very slightly shorter, and at middle and posteriorly slightly lower than the right one.

Surface measurements of the two parietals:

Junction of squamous and malo-frontal sutures,	left	4.75,	right	4.75	cm.
Infero-superiorly at middle	"	4.8	"	5.0	"
Asterion to lambda	"	2.9	"	3.0	"
Junction of squamous and malo-frontal sutures,	"	4.65	"	4.6	"
Antero-posteriorly at middle	"	5.05	"	5.0	"

GROUP 6. ANTERO-POSTERIOR PARIETAL DIVISIONS IN MONKEYS.

Case 30. *Cynocephalus mormon*, male, adolescent; No. 121, M. D., C. U., N. Y.

The left parietal bone is partly divided by a suture, which begins distally in a notch in the sagittal border of the bone, 2.5 cm. from the bregma and 0.6 cm. from the lambda. The division is 2.5 cm. long, quite straight, slightly serrated, and runs in a downward and slightly forward direction to the parietal eminence. The median fourth of the division shows some occlusion. The parietal eminence on this side is represented by a circular, rather broad but low bulging, with a moderate central depression. A shallow groove runs from this depression forward toward the coronal suture, representing the anterior part of a complete antero-superior division. There is no trace of any inflammatory action, and the indications are against the depression being due to an injury. (Pl. XII.)

The sagittal third of the divided parietal is somewhat more bulging than the same region on the right, and the whole left parietal bone is slightly higher, but shorter, than the right one.

Case 31. *Macacus rhesus*, male, adolescent; No. 145, M. D., C. U., N. Y.

This specimen presents a beautiful division of each parietal by a curved antero-posterior suture.

The suture begins on the frontal border of the parietal

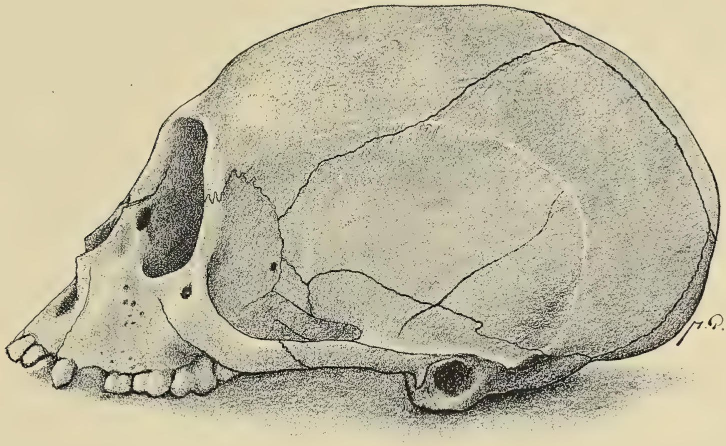


FIG. 1.

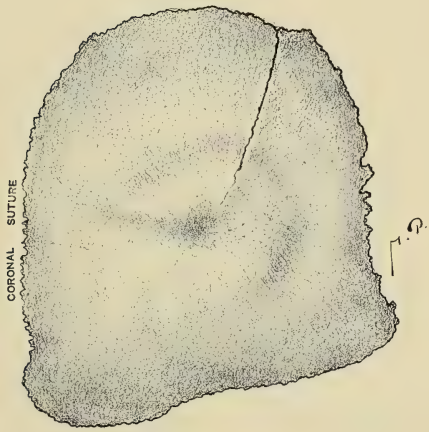
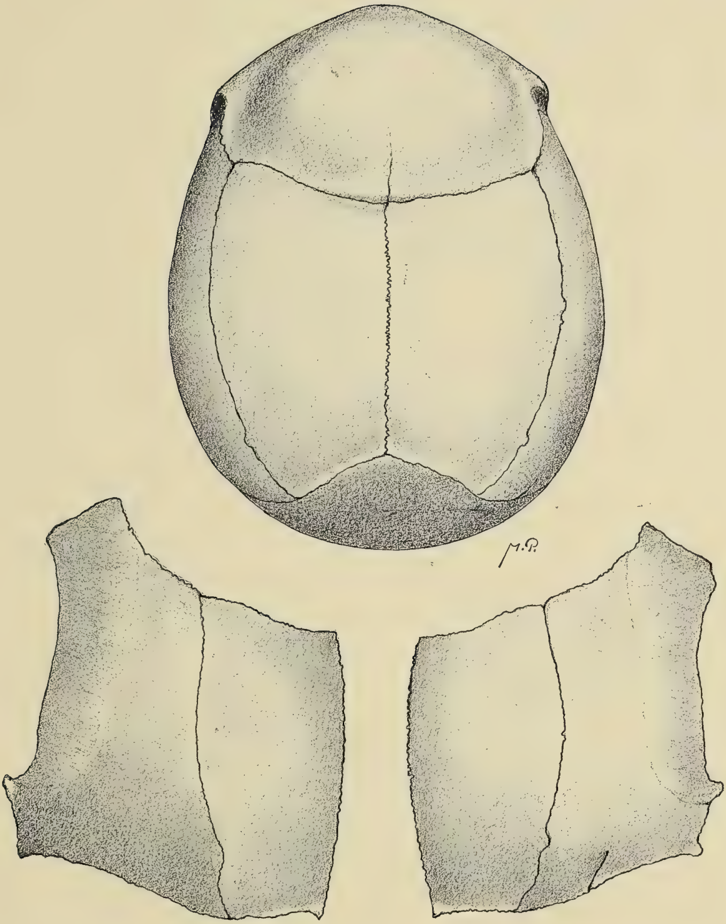


FIG. 2.

FIG. 1.—CEBUS HYPOLEUCUS (NO. 10,720, A. M. N. H.). PARIETO-TEMPORAL DIVISION ON THE LEFT SIDE.

FIG. 2.—CYNOCEPHALUS MORMON (NO. 121, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). INCOMPLETE VERTICAL DIVISION IN THE LEFT PARIETAL.



MACACUS RHESUS (NO. 145, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). BILATERAL ANTERO-POSTERIOR PARIETAL DIVISION.

bones, the left 2.25 cm., the right 1.7 cm. from bregma. They both proceed in a gentle, symmetrical curve backward, to end each on the occipital border of the parietal bones, 1 cm. from lambda. Both sutures are open and of a squamous character, the border of the inferior position of each bone overlapping that of the superior one.

Eleven mm. below the termination of the right anomalous suture, the occipital border of the parietal is divided by a 1.5 cm.-long, open fissure, which runs parallel with the suture. (Pl. XIII.)

Measurements of the two parietals:

Length, along sagittal border	left 3.5,	right 3.5	cm.
" squamo-coronal point to asterion	" 4.45	" 4.5	"
Hight, " " " " bregma	" 4.5	" 4.2	"
" at middle	" 4.8	" 4.7	"
" asterion to lambda	" 4.1	" 4.0	"

The left parietal is higher than the right, especially anteriorly; this, however, does not affect appreciably the symmetry of the whole cranium.

The skull shows no further anomalies and no signs of any injury. The normal sutures are all pervious. There are no Wormians.

Case 32. *Macacus rhesus*, sex unknown, adolescent; No. 195, M. D., C. U., N. Y.

The left parietal bone shows a 3-millimeters-long, slightly oblique incisure in its posterior border, a short distance above the asterion. No other anomalies.

Case 33. *Macacus erythræus*, sex unknown, adolescent; No. 1616, A. M. N. H., N. Y.

Fig. 20. *Macacus erythræus* (No. 1616, A. M. N. H.). Division in the left parietal.

The left parietal bone shows a 1.35-cm.-long, antero-pos-

terior division in the middle of its posterior, and a 0.3 cm.-deep, V-shaped notch, situated immediately above the temporal ridge, in its anterior portion.

The posterior division runs in a slightly wavy course forward and a little downward; its anterior half is occluded. The notch in the anterior portion of the bone is filled with an ossicle.

The skull is asymmetrical in the parietal region; the left parietal bone is slightly smaller and less bulging than the right one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma	left 4.0,	right 4.1 cm.
Infero-superiorly at middle	" 4.3	" 4.35 "
Asterion to lambda	" 3.1	" 3.2 "
Squamo-coronal junction to asterion	" 4.35	" 4.35 "
Antero-posteriorly at middle	" 4.85	" 5.1 "

There are no signs of any injury or further anomalies.

Case 34. *Cebus capucinus*, male, young; No. 164, M. D., C. U., N. Y.

There is a horizontal incisure 0.9 cm. long in the anterior portion of the right and a similar incisure 0.6 cm. long in the anterior portion of the left parietal bone, both situated a short distance above the sphenoid angle.

Skull symmetrical, parietals nearly equal. No injuries or further anomalies. (Compare *Cebi* 5050, 11037, 6323.)

Case 35. *Ateles belzebub*, sex unknown, adolescent; No. 119, M. D., C. U., N. Y.

There is a horizontal fissure 0.3 cm. long in the anterior portion of the left parietal, slightly below its middle. The temporal ridge passes beneath the fissure.

The skull shows no other exceptional features.

Case 36. *Ateles vellerosus*, male, nearly adult; No. 14484, A. M. N. H., N. Y.

The left parietal bone shows an oblique antero-posterior, well serrated, but for the most part obliterated anomalous division.

The still visible part of the suture begins distally on the occipital border of the parietal, 5 mm. above the asterion.

The suture runs horizontally, until it reaches the temporal ridge, after which it curves slightly and runs forward and upward, on to the parietal eminence. Beyond the eminence the division, which up to that point was but slightly so, becomes entirely obliterated. The anomalous suture shows considerable serration (for a suture in an *Ateles*). (Pl. XV.)

Surface measurements of the two parietals:

Length, at middle	left 6.05,	right 6.35	cm.
" junction of coronal and malo-frontal sutures to asterion	" 5.1	" 5.5	"
Hight, junction of coronal and malo-frontal sutures to bregma	" 5.7	" 5.6	"
" at middle	" 5.9	" 5.9	"
" asterion to lambda	" 3.0	" 2.7	"

The right parietal is somewhat longer, but anteriorly as well as posteriorly slightly lower than the left bone.

The skull is not perceptibly asymmetrical, and shows no signs of injuries or any further anomalies, with the following exceptions: There are nine Wormian bones in the coronal suture (5 small ones on left, 4 larger on right); the bregma fontanel is occupied by five comparatively large Wormians; and there are 20 small Wormian bones in an irregular row in the anterior two thirds of the sagittal suture. In addition there is a moderate-sized intercalate bone in the right asterion.

GROUP 7a. INSTANCES OF COMPOUND INCOMPLETE PARIETAL DIVISIONS IN MONKEYS.

Case 37. *Macacus rhesus*, female, adolescent; No. 20, M. D., C. U., N. Y.

The mastoid portion of the right parietal bone is divided by a slightly serrated, 1.35-cm.-long suture. The division begins in the middle of the mastoidal margin, runs for a short distance forward, then bends and proceeds forward and upward, in the direction of the parietal eminence, until it reaches the temporal ridge, between the boundaries of which it ends. The further course of the suture cannot be followed. The sagittal border of the bone shows, a little anterior to its middle, a slight vertical incisure; it is possible that this point marks

the original superior termination of the postero-inferior division.

The left parietal bone shows a 1.6-cm.-long, straight trace of a division which began in the sagittal border of the bone, 0.35 cm. anterior to the little incisure on the right (1.65 cm. from bregma, 3.1 cm. from lambda), and ran in a slightly converging course with the lambdoid suture.

The skull is symmetrical and free from other anomalies. The right parietal bone slightly exceeds the left one in the inferior length (by 0.1 cm.), otherwise the bones are equal.

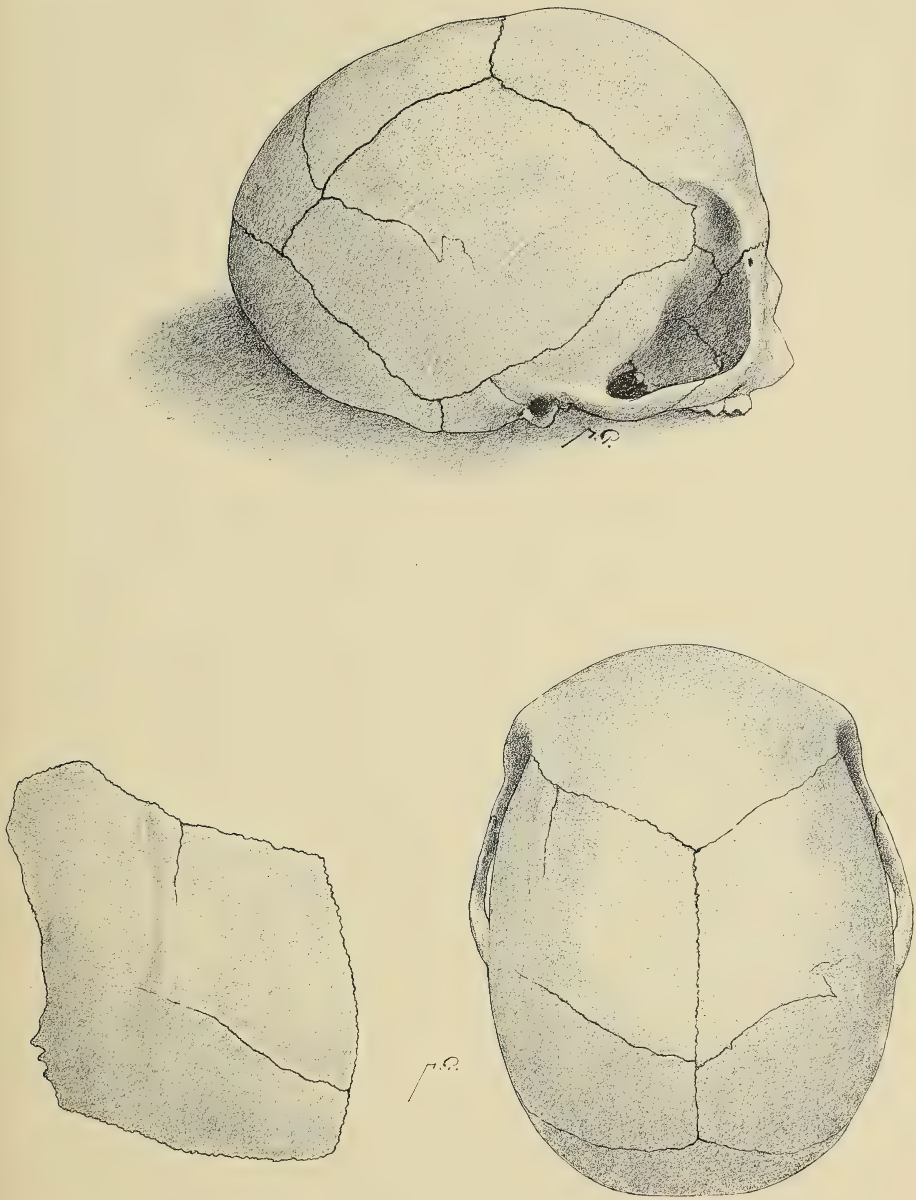
Fig. 21. *Macacus rhesus*, female (No. 20, Morphological Museum, Columbia University). Suture in the mastoid angle of the right parietal.

Case 38. *Macacus rhesus*, sex unknown, adolescent; No. 58, M. D., C. U., N. Y.

Both parietal bones show incomplete divisions. There are a vertical and a horizontal division on the left, and a vertical one on the right side.

The vertical divisions begin opposite in the sagittal border of the bones, slightly posterior to the third fourth of the same (3.2 cm. from bregma, 0.9 cm. from lambda), and both run with a slightly wavy course in the direction of the parietal eminence. That on the right terminates 1.15 cm. from its superior end; that on the left is 2.5 cm. long and terminates directly above the upper boundary of the temporal ridge. Both these divisions show some fine serration. When the parietal bones are viewed against the light, a dark line, undoubtedly a former extension, is seen running from each of the divisions and in the same direction with their patent portions toward the squamous suture.

The horizontal division in the left parietal begins nearly



L.

MACACUS RHESUS (No. 58. MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY).
PARIETAL DIVISIONS.

at the middle of its anterior border (2.1 cm. from the lower end of the coronal suture, 2.0 cm. from bregma) and a little above the temporal ridge. It runs nearly parallel with the squamous suture, is 0.8 cm. long, slightly wavy, and shows traces of occlusion. (Pl. XIV.)

The skull is symmetrical and without signs of any injury, or other marked exceptional features. The right parietal is throughout somewhat higher than the left, but the length of the two is nearly equal.

Surface measurements of the parietal bones:

Squamo-coronal junction to bregma	left	4.0,	right	4.2	cm.
Infero-superiorly at middle	"	4.1	"	4.25	"
Asterion to lambda	"	2.95	"	3.1	"
Squamo-coronal junction to asterion	"	4.4	"	4.35	"
Antero-posteriorly at middle	"	4.5	"	4.5	"

Case 39. *Macacus rhesus*, sex unknown, young adolescent; No. 114, M. D., C. U., N. Y.

The left parietal shows an incomplete anterior horizontal, the right, traces of what probably was a complete vertical division.

The division on the left is very much like that in Macaque No. 58. It begins in the anterior border of the parietal, 1.4 cm. from the squamo-coronal junction, 2.65 cm. from bregma, 0.5 cm. above the upper boundary of the temporal ridge. It runs in a slightly wavy course and with a few fine serrations backward and a little downward, until it reaches the temporal ridge, beyond which point it is obliterated. Externally the division is 0.8 cm. long; ventrally it runs 0.35 cm. further, reaching a total length of 1.15 cm.

The division on the right begins superiorly by a 2-millimeter-long slit in the sagittal border of the parietal, at a point distant 2.7 cm. from bregma and 1.85 cm. from lambda. The division runs downward, converging slightly with the lambdoid suture. Above the temporal ridge it curves moderately backward; beyond this curve all its traces are obliterated. Apparently the division terminated in or near the mastoid angle of the parietal.

The skull is symmetrical; no signs of any injuries and no

other anomalies. The right parietal bone is both longer and higher than the left one.

Surface measurements of the two parietals:

Squamo-coronal junction to bregma	left	4.05,	right	4.3	cm.
Infero-superior at middle	"	4.4	"	4.5	"
Asterion to lambda	"	3.2	"	3.2	"
Squamo-coronal junction to asterion	"	4.2	"	4.3	"
Antero-posteriorly at middle	"	4.7	"	4.8	"
" " along sagittal suture	"	4.55	"	4.9	"

Case 40. *Cebus capucinus*, female, young adolescent; No. 6323, A. M. N. H., N. Y.

The left parietal shows a forked antero-posterior, the right a partial vertical and a segment of an antero-posterior division.

The division on the left begins in a cleft, now filled with an ossicle, in the anterior portion of the parietal, somewhat below the temporal ridge. It runs for a short distance as a single branch and then divides, the inferior portion, 0.55 cm. long, passing almost directly downward, while the superior portion, 0.9 cm. long, bends upward and then backward and runs in the direction of the mastoid angle.

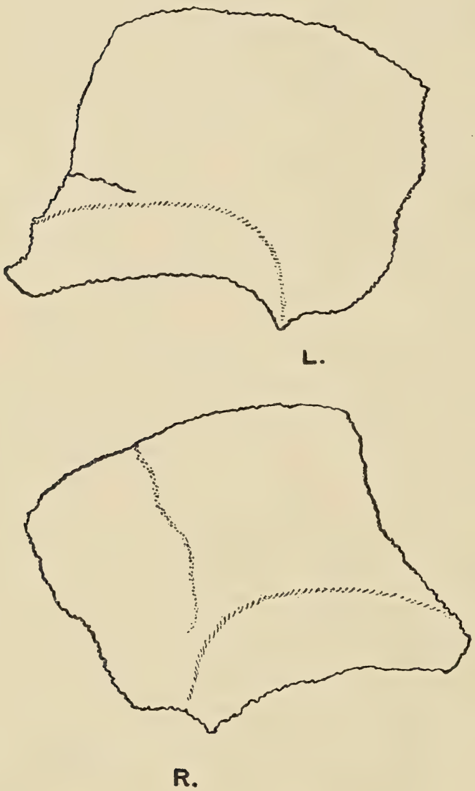


Fig. 22. *Macacus rhesus* (No. 114, Morphological Museum, Columbia University). Parietal divisions.

On the right side the vertical division, an 0.8-cm.-long, narrow cleft, begins superiorly in the sagittal border of the parietal, 0.7 cm. anterior to the lambda, and runs slightly divergent with the lambdoid suture. In addition the bone shows, on its anterior third and somewhat below the temporal ridge, a 0.9-cm.-long, patent segment of an antero-posterior division. A slight notch in the anterior border of the bone at about the same hight marks probably the original anterior termination of this division.

The skull is symmetrical; the parietals show but insignificant differences in dimensions. No signs of injury and no further anomalies.

The case is allied to those of *Cebi* 5050 and 11037, A. M. N. H. (*q. v.*).

Fig. 23. *Cebus capucinus* (No. 6323, A. M. N. H.). Incomplete parietal divisions.

Case 41. *Cebus*, adolescent, species and sex not determined; No. 143, M. D., C. U.

The skull shows two parietal divisions, one oblique and one horizontal, in the right, and a partial oblique division in the left parietal.

The oblique divisions begin on each side by a cleft in the postero-superior angle of the parietal, and run, as narrow clefts, downward and somewhat forward. The left division is 6.5 millimeters long. That on the right is in two segments, being interrupted by a narrow band of ossification; it

measures *in toto* 3.1 cm.; its inferior extremity is lost, just above the temporal ridge.

The horizontal division on the right begins in the posterior border of the parietal, 0.9 cm. below the lambda and 1.6 cm. above the asterion; it is straight, 0.5 cm. long and serrated. (Pl. XV.)

The skull is symmetrical and without further anomalies; the parietals are nearly equal.

Case 42. *Ateles ater*, sex unknown, adolescent; No. 1628, A. M. N. H., N. Y.

There are two pronounced incisures in the left, and one in the right parietal bone.

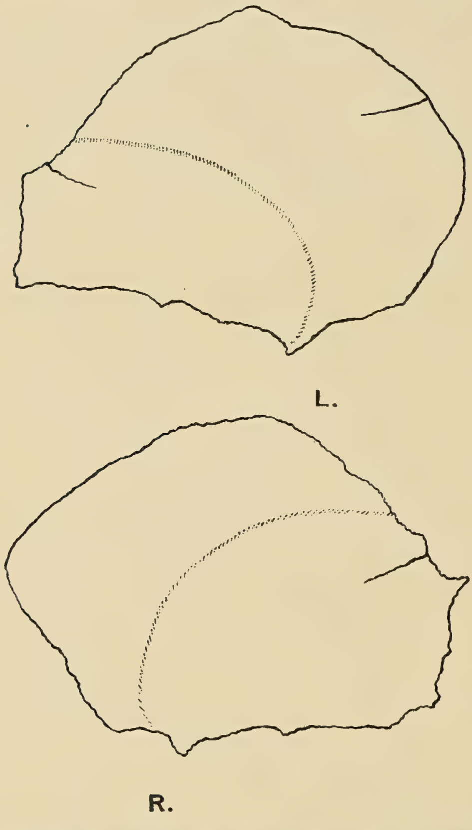


Fig. 24. *Ateles ater* (No. 1628, A. M. N. H.). Parietal incisures.

Of the incisures on the left, one is situated in the anterior, and the other in the superior portion of the bone. The anterior division begins distally 1.6 cm. above the point of junction of the coronal and malo-frontal sutures, 3.5 cm. below the bregma, and 0.8 cm. below the temporal ridge. The incisure is 0.8 cm. long, slightly wavy, and directed backward and very slightly downward. The second division on the left side begins superiorly between the third and last fourths of the sagittal border of the parietal (2.4 cm. from bregma, 0.8 cm. from

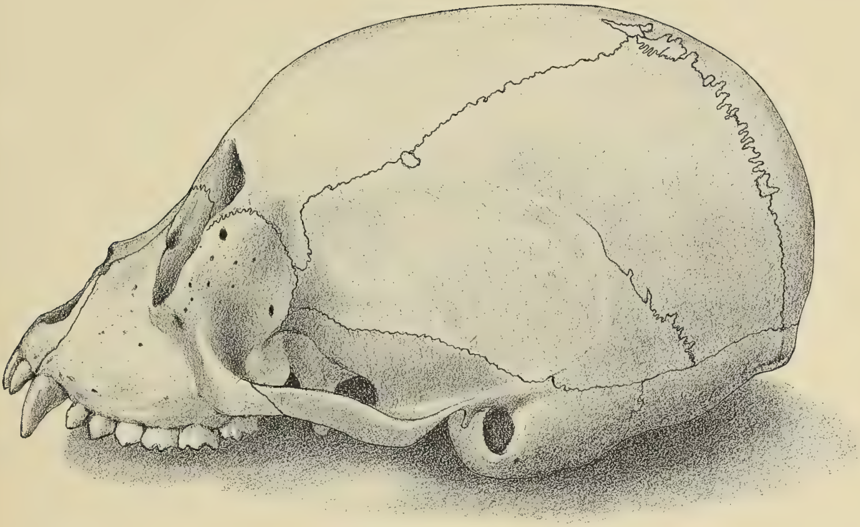


Fig. 1.

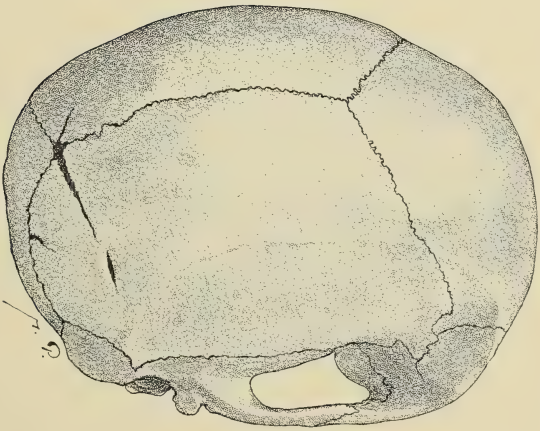


Fig. 2.

Fig. 1.—Ateles (No. 14,484, A. M. N. H.). Partly Obliterated Division of the Left Parietal.

Fig. 2.—Cebus (No. 143, Morphological Museum, Columbia University). Parietal Divisions.

lambda), is 1.4 cm. long, and runs obliquely downward and somewhat forward.

The incisure in the right corresponds to the anterior division in the left parietal. It begins distally 1.6 cm. above the point of junction of the coronal and malo-frontal sutures, 3.6 cm. below the bregma and 0.8 cm. below the temporal ridge. It is 0.9 cm. long and runs in a nearly straight course backward and somewhat downward.

The skull is quite symmetrical. No signs of injuries or further anomalies. The right parietal is higher in its middle three fifths than the left one (infero-superiorly at middle, right 4.5 cm., left 4.2 cm.), but other measures of the bones are equal. There are traces of occlusion in the lower fourths of the coronal sutures.

Case 43. *Ateles*, male, young; No. 6313, A. M. N. H., N. Y.

The skull shows five marked incisures in the right, and two in the left parietal bone. Of those on the right, two are in the anterior, two in the posterior, and one in the superior portion; of those on the left, one is in the anterior and one in the posterior portion of the bone.

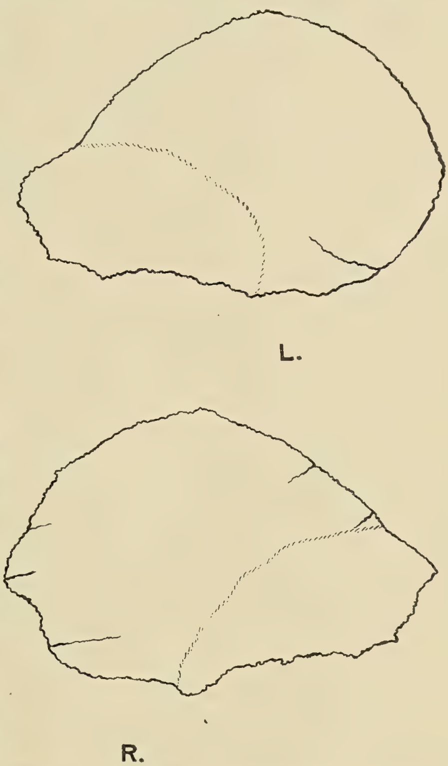


Fig. 25. *Ateles* (No. 6313, A. M. N. H.). Parietal incisures.

The lower of the two anterior divisions on the right begins distally 1.1 cm., the higher one 2.0 cm. above the junction of the coronal and malo-frontal sutures, or, respectively 3.1 cm.

and 2.2 cm. from the bregma. The inferior division is situated a short distance above the temporal ridge, is 0.45 cm. long, straight, and directed backward and slightly downward. It runs up to the temporal ridge. The superior incisure is also 0.45 cm. long and straight, and runs parallel with the lower division.

Of the two posterior incisures on the right, the lower begins distally 0.9 cm. above the asterion, or 1.8 cm. from the lambda, while the higher one begins distally at the lambda itself. Both the incisures are straight, and run forward and slightly downward; the lower one is 1.0 cm., the upper one 0.7 cm. long.

The sagittal division begins superiorly 0.7 cm. from the lambda, is 0.7 cm. long, and runs in a downward and forward direction.

The anterior division on the left begins distally 0.9 cm. above the point of junction of the coronal and malo-frontal sutures, and slightly above the temporal ridge; it is 0.35 cm. long, straight, and runs backward and slightly downward to the ridge.

The posterior left division begins distally 0.9 cm. above the asterion, or 1.85 cm. from the lambda, is 1.0 cm. long, straight, and directed forward and slightly downward.

The skull is quite symmetrical, the parietals nearly equal. There are no signs of injuries, or other anomalies.

Case 44. *Ateles*, species not determined (probably *A. vellerosus*), male, adolescent; No. 13690, A. M. N. H., N. Y.

The right parietal bone shows two partial divisions, one in its sagittal, the other in its posterior border.

The vertical incisure begins superiorly at very near the middle of the sagittal border, is 1.35 cm. long, nearly straight, and runs downward and somewhat backward. The lower fifth of the division shows advanced occlusion.

The posterior incisure is 0.5 cm. long, and straight; it begins distally in the middle of the occipital border of the parietal, and runs forward parallel with the horizontal axis of the bone.

The skull shows several other peculiarities. The fontanel at bregma is filled with a quite large, somewhat diamond-

shaped separate bone; and there is on each side in the lower part of the coronal suture a number of moderate-sized to comparatively large Wormians. On the left, one of these Wormian bones enters 0.85 cm. deep into the anterior portion of the parietal bone, just below the temporal ridge. (Pl. XVII, Fig. 1.)

The two parietals are equal in height, but the right bone is longer than the left one.

Surface measurements of the two parietal bones:

Point of junction of the squamous and temporo-sphenoidal sutures to bregma	left 6.2,	right 6.2	cm.
Infero-superiorly at middle	" 6.1	" 6.1	"
Asterion to lambda	" 3.9	" 3.9	"
Point of junction of the squamous and temporo-sphenoidal sutures to asterion	" 4.05	" 4.25	"
Antero-posteriorly at middle	" 6.1	" 6.2	"

GROUP 7b. INSTANCES OF COMPOUND COMPLETE PARIETAL DIVISIONS IN MONKEYS.

Case 45. *Cercopithecus callitrichus*, female, adult; No. 13923, A. M. N. H., N. Y.

The left parietal bone shows a complete vertical division, and this is met at the squamous suture by an incisure in the temporal squama running in the same direction. On the right side there is a complete separation by an oblique suture of the postero-inferior portion of the parietal, and in addition traces of a vertical division.

The anomalous division in the left parietal bone begins superiorly at a point distant 0.85 cm. from the lambda and 2.25 cm. from the bregma. It passes downward and slightly forward to the temporal ridge, where it makes a bend, and after that descends more directly downward, running nearly parallel with the coronal suture. With the exception of a few points of occlusion the division is patent, and it shows a moderate serration.

The temporal fissure begins superiorly at a point slightly anterior to that at which the parietal meets the squamous suture, is 0.65 cm. long, though traceable a little further

downward, and runs with a slightly wavy course to the upper portion of the supra-zygomatic fossa.

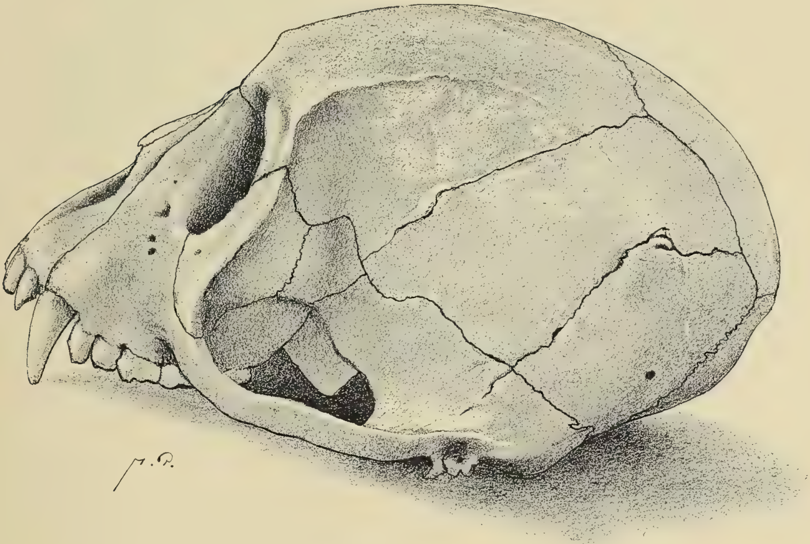
On the right side both the vertical and the oblique divisions begin inferiorly at the same point, which is distant 1.4 cm. from the asterion and 2.6 cm. from the point of junction of the temporo-parietal and temporo-sphenoidal sutures. The vertical division is almost entirely occluded, but can be traced for 2.2 cm. above the squamous suture, running upward and slightly backward. Six millimeters above the border of the temporal bone we find in the course of the vertical division a moderate-sized oblong foramen, and there is a similar opening at exactly the same hight in the left parietal suture.

The oblique division on the right passes backward and upward, terminating 0.8 cm. above the asterion. The piece of bone it separates is of a triangular shape and measures 0.8 x 1.4 x 1.65 cm. An oblong opening, slightly larger than that in the right vertical, is found also in the anterior portion of the oblique division. On the left side there is no oblique or antero-posterior division discernible, but 1.1 cm. vertically above the squamous and 0.3 cm. from the lambdoid suture is a quite large, ventrally occluded foramen, which possibly is a remnant of such a separation. The portion of the left parietal below the slightly oblique line which passes from the foramen in the vertical, through the more posterior isolated foramen, to the lambdoid suture, is somewhat flattened.

The skull is symmetrical, and there is no trace of any injury. *The left malar bone is divided by a serrated, horizontal, still patent suture.* (Pl. XVI.)

Of the two parietals the left one is a little higher anteriorly and posteriorly, but slightly lower at middle, and shorter both inferiorly and at middle, than the right one. The surface measurements are as follows:

Junction of squamous and temporo-sphenoidal sutures to bregma	left 4.3,	right 4.1	cm.
Infero-superiorly at middle	" 3.7	" 3.9	"
Asterion to lambda	" 3.2	" 3.0	"
Junction of squamous and temporo-sphenoidal sutures to asterion	" 3.7	" 4.0	"
Antero-posteriorly at middle	" 4.3	" 4.4	"



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R.P.

Cercopithecus callitrichus (No. 13,923, A. M. N. H.). Parietal Divisions. Malar division.

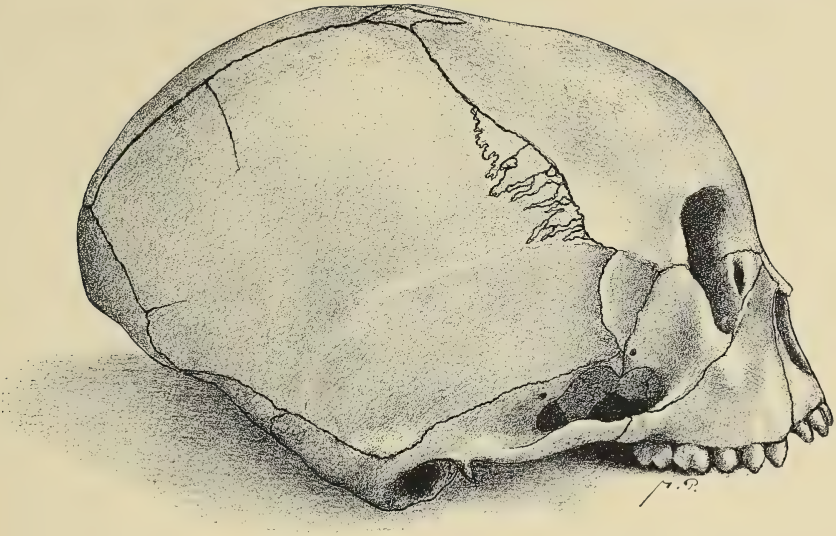


FIG. 1.

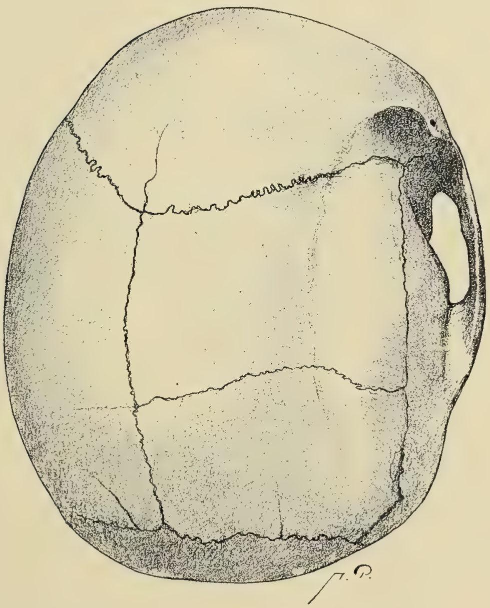


FIG. 2.

FIG. 1.—ATELES (No. 13,690, A. M. N. H.). PARTIAL SUTURES IN THE RIGHT PARIETAL.

FIG. 2.—MACACUS RHESUS (No. 46, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY). VERTICAL PARIETAL DIVISION.

Case 46. *Macacus rhesus*, sex unknown, adolescent; No. 46, M. D., C. U., N. Y.

The specimen shows a complete vertical, and traces of a partial horizontal division of the right, and remnants of two divisions, one vertical and one oblique, on the left parietal bone.

The vertical suture on the right begins superiorly a little posterior to the middle of the sagittal border of the bone (2.6 cm. from the bregma, 1.85 cm. from the lambda). It runs very nearly parallel with the lambdoid suture up to the temporal ridge, at which it curves slightly backward. It terminates 3.1 cm. posterior to the squamo-coronal junction and 1.8 cm. anterior to the asterion.

The suture is throughout patent. It is throughout moderately squamous in character, the border of the anterior overlapping that of the posterior portion of the parietal; at the same time the suture shows externally a fair serration.

The horizontal division can be traced as a slight, straight elevation, running from the middle of the posterior border of the parietal 1.2 cm. forward, parallel with the sagittal suture.

The vertical division on the left parietal bone began sagitally exactly opposite the similar division on the right side. It is completely occluded, but can be plainly traced for 1.3 cm., running straight downward parallel to the lambdoid suture.

The oblique division on the left, probably the counterpart of the horizontal one on the right, begins as an open fissure 3 millimeters below the lambda. The fissure becomes soon occluded, but can be traced, running in a straight line in the direction of the parietal eminence, for 1.0 cm. (Pl. XVII, Fig. 2.)

The skull is fairly symmetrical and shows no further anomalies. The right parietal is slightly longer at middle, but slightly lower, especially at middle, than the left one.

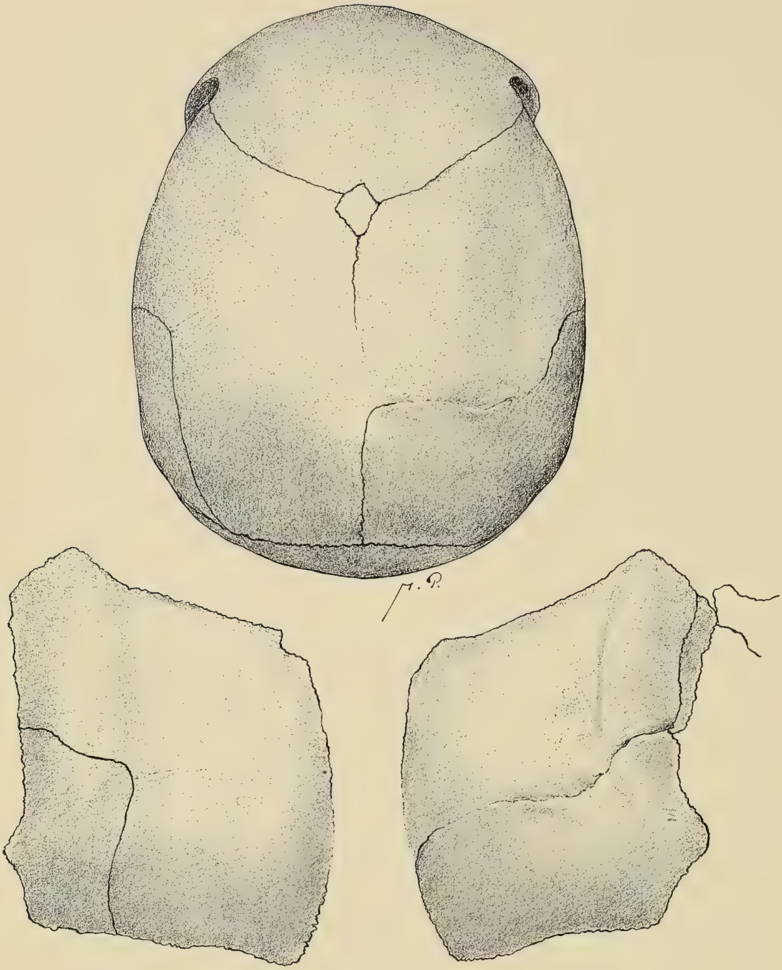
Surface measurements of the two parietal bones:

Squamo-coronal junction to bregma	left	4.3,	right	4.2	cm.
Infero-superiorly at middle	"	4.2	"	3.9	"
Asterion to lambda	"	3.2	"	3.2	"
Squamo-coronal junction to asterion	"	4.9	"	4.9	"
Antero-posteriorly at middle	"	5.0	"	5.1	"

Case 47. *Macacus rhesus*, sex unknown, adolescent; No. 50, M. D., C. U., N. Y.

The skull presents a complete, partly occluded vertical division of the right, and a fully patent vertical-horizontal division of the left parietal bone.

The division on the right side begins superiorly somewhat posterior to the middle of the sagittal border of the parietal (about 2.6 cm. from bregma, 1.8 cm. from lambda) and, a portion of the sagittal suture immediately in front being obliterated, it appears like a prolongation of the posterior, patent segment of the suture. Four and a half millimeters from the line of the sagittal suture the division becomes totally occluded, but, if the skull is inclined in a certain way to the light, the line of the division can be quite plainly traced. This mark runs almost straight downward, parallel with the lambdoid suture, and in the lower third of the parietal joins the inferior open portion of the division. This latter portion, which shows the character of a squamous suture, with the border of the posterior piece overlapping that of the anterior one, makes a moderate knee-like deflection forward and downward, and after a course of 1.5 cm. reaches the temporo-parietal suture, slightly anterior to the middle point between the squamo-coronal junction and asterion. But the division does not end here. Externally, following directly in its course, but soon bending forward, is a squamous suture, which runs to the temporo-sphenoidal suture and apparently has separated a portion of the temporal squama 2.1 cm. long by 0.55 cm. in its greatest hight. Ventrally, the right parietal bone is seen to reach throughout its anterior two thirds unusually low, much more so than the left one; the overlapping of the inferior portion by the temporal squama is very considerable, averaging nearly 0.5 cm. in hight. The parietal division proceeds in the same direction in which it reached the squamous suture to the border of the bone. The portion of the parietal anterior to the division reaches the wing of the sphenoid. The squamous suture, which appears externally like the continuation of the parietal division, is seen running immediately below the anterior half of the lower border of



L. R.

MACACUS RHESUS (NO. 50, MORPHOLOGICAL MUSEUM, COLUMBIA UNIVERSITY).
PARIETAL DIVISIONS.

this portion. The hight of the temporal squama from the external border of the glenoid fossa to the beginning of the fronto-parietal suture is 1.7 cm. on the left, 1.95 cm. on the right (including the 0.55 cm. high separate portion).

The left parietal shows what is probably the lower portion of a formerly complete vertical division, and a horizontal suture passing from this to the posterior border of the bone.

The vertical division begins inferiorly at a point distant 1.8 cm. from the squamo-coronal junction and 3.0 from the asterion. It is of a squamous character, the border of the posterior separate portion overlapping that of the anterior one. It runs in a nearly straight course for 1.7 cm. upward, parallel with the coronal suture. At this point it ends and is joined at nearly a right angle by the antero-posterior suture. The separated piece of the parietal being removed, a small oblique incisure is seen in the angle between the two divisions, and above this incisure the surface of the bone bears slight traces of an extension of the vertical suture.

The antero-posterior division is also nearly straight and of a squamous character, the border of the lower overlapping the anterior half of the border of the upper separate part. It runs parallel to the sagittal, but converges somewhat from before backward with the squamous suture. It terminates in the posterior border of the parietal, 0.5 cm. above the asterion. (Pl. XVIII.)

The skull is quite symmetrical. It is larger than the average macaque skull at a similar period of life, and shows ventrally marked impressions of cerebral convolutions. The right parietal bone exceeds the left one in its antero-posterior dimensions, while the hight, except along the coronal suture, shows externally no difference. Ventrally the right parietal is also higher.

Surface measurements of the two parietal bones:

Squamo-coronal junction to bregma.........	left	5.0,	right	4.75 cm.
Infero-superiorly at middle..................	"	4.7	"	4.7 "
Asterion to lambda..........................	"	3.0	"	3.0 "
Squamo-coronal junction to asterion.........	"	4.8	"	5.1 "
Antero-posteriorly at middle................	"	4.95	"	5.25 "

The middle third of the sagittal suture is obliterated; other normal sutures are patent. There is a moderately large, irregularly quadrilateral bregmatic bone.

Case 48. *Macacus rhesus*, sex ?, adolescent, No. 102, M. D., C. U., N. Y.

This skull presents a number of puzzling features. The parietal bones show several divisions, and two of these appear to be prolonged into the adjoining parts of the frontal and temporal squamæ. The majority of the divisions have the appearance of, and in all probability are, genuine anomalous parietal sutures, but two of the smaller divisions on the right side suggest by their location and character more a possible injury, of which, however, there are no distinct signs present. After many repeated and careful examinations, it seems equally improbable that all the divisions are natural anomalies, or that they are all due to some injury. The most probable fact is that we have here a combination of highly interesting anomalous divisions with some secondary effects of violence, — a violence, perhaps, of some peculiar nature.

The left parietal bone is divided into three large, more or less quadrilateral segments, two anterior and one posterior, by two true anomalous sutures, one vertical and one horizontal. The vertical suture begins sagitally 2.2 cm. posterior to bregma and 2.1 cm. anterior to lambda, proceeds almost parallel to the coronal suture, reaches the squamous suture 1.5 cm. posterior to the junction of this with the coronal, bends and runs 0.85 cm. forward and downward into a notch in the border of the temporal squama, then bends again and passes for a little over two millimeters directly downward into the squama itself. Ventrally the division continues from this point directly forward as the spheno-parietal suture, bounding a long, narrow, subsquamous sphenoidal process of the parietal bone. A similar, though shorter sphenoidal process exists on the opposite side.[1] The course of this vertical suture in the left parietal is almost straight, with the exception of a moderate double curve above the temporal ridge. The suture is of a squamous

[1] Similar processes exist in other macaques, with the result that while externally there is a fronto-temporal, we have internally a parieto-sphenoidal articulation; and this condition is not restricted to these monkeys.

nature, particularly inferiorly. Superiorly the posterior segment of the parietal overlaps slightly the superior anterior one, while inferiorly the conditions are reversed, the inferior anterior portion overlapping to a marked degree the posterior one.

The horizontal or antero-posterior division on the left begins in the anterior border of the parietal 2.5 cm. above the squamo-coronal junction, or 1.9 cm. inferiorly to the bregma, and proceeds with a moderate curve backward and slightly downward to a little below the middle of the vertical suture. The suture is partly squamous, the superior overlapping somewhat the inferior portion of the parietal. From the anterior extremity of this suture a partial division passes into the frontal squama. This division is obliterated, but can be plainly traced; it is straight, 1.2 cm. long, and directed toward the frontal eminence.

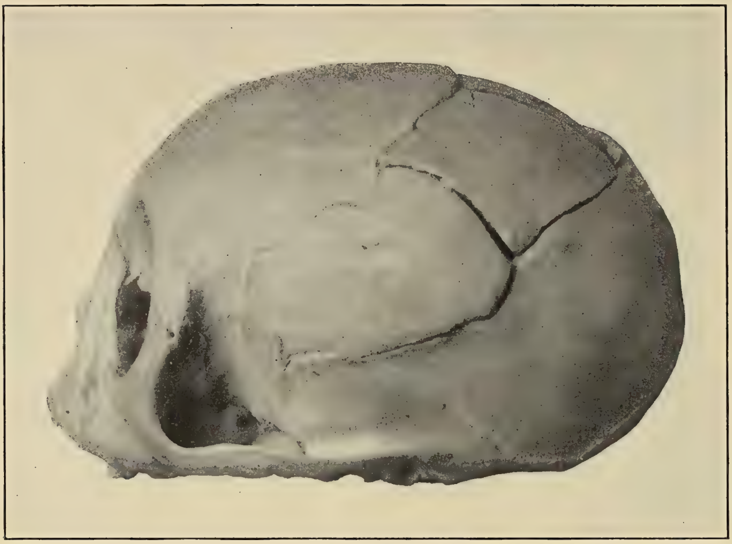
There is not the slightest trace of any injury on the left side of the skull, and the character of the divisions is such that they cannot be regarded as anything else than anomalous sutures. The coexistence of the incisure in the temporal squama can, I think, be attributed to a mechanical interference in the growth of that part of the squama caused by a somewhat uneven growth (the anterior part is even now higher) of the underlying portions of the two segments of the parietal. The frontal division is more difficult to be accounted for, nevertheless a method suggests itself by which it may have been produced by the influence of the horizontal parietal division. This point will be dealt with at the end of this paper.

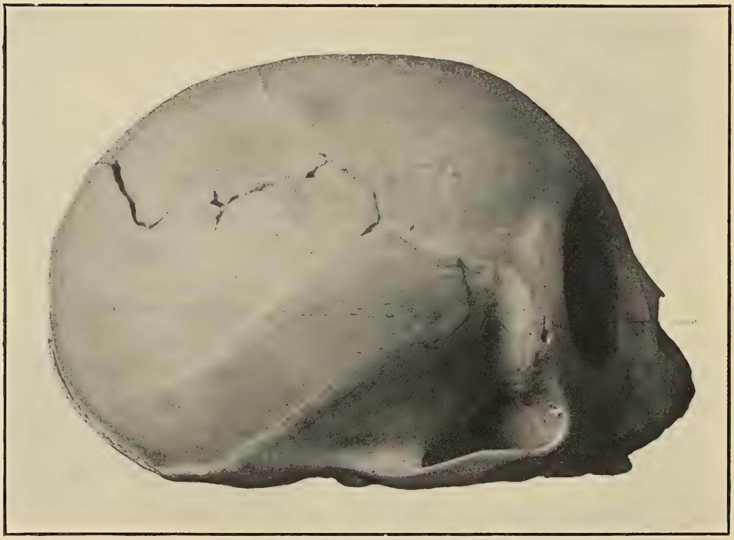
The right parietal bone of the skull under consideration presents a partial vertical and a partial horizontal suture, which separate a quadrilateral piece of the antero-superior portion of the bone. The piece is much like the antero-superior segment of the left parietal, and is very probably of a similar origin, the sutures separating it being true anomalous divisions. The vertical suture begins on the sagittal border of the parietal two millimeters anterior to that on the left, namely, 2.25 cm. from the bregma and 2.15 cm. from the lambda. It

is nearly straight, parallel to the coronal suture, and inferiorly slightly squamous, the adjoining part of the parietal overlapping here the separated segment. Eighteen millimeters below the sagittal suture the vertical meets an antero-posterior division. This latter begins 2.1 cm. below the bregma, hence two millimeters lower than the antero-posterior division on the left. It runs 1.4 cm. backward and slightly upward, then makes a sharp, irregular bend and runs 3 mm. upward, after which it bends again and runs 7 mm. backward, parallel with the sagittal suture, and meets the vertical division. From the bend and from the angle between the horizontal and vertical sutures, two incisures, nearly straight, and for the most part obliterated, the inferior 1.1 cm., the superior 0.9 cm., run backward and downward into the parietal. Ventrally it is seen that these two divisions have joined, separating a piece of bone 2.3 cm. long by 0.7 cm. in maximum hight. This piece is subdivided by a vertical slit, which is directly continuous with the vertical division, but is obliterated dorsally, into two smaller portions.

On the same parietal (right) we find still another division. It is an incomplete antero-posterior suture of squamous nature, beginning 3.15 cm. below the bregma, 1.55 cm. above the squamo-coronal junction, and ending within 7 millimeters from the lambdoid suture. The course of this division for the anterior three fourths of its extent is parallel to the squamous suture, but then it makes a moderate curve upward. The border of the lower portion of the parietal along this division is higher than the upper portion and overlaps the same. The more superior partial antero-posterior division is but slightly squamous, but there also the border of the inferior tends to overlap that of the superior portion; but in the two shorter divisions which begin from this superior horizontal suture, the conditions are reversed, the superior borders distinctly overlapping the inferior. On the left, as remarked before, the border of the superior overlaps that of the inferior portion.

The inferior horizontal division is mostly closed, only 1.2 cm. of its anterior end remaining patent. It opens by a





Macacus rhesus (No. 102, Morphological Museum, Columbia University). Showing a Parietal and a Partial Temporal Division.

slight cleft into a wide, 2.5 millimeters deep, V-shaped indentation in the anterior border of the parietal. A similar indentation is found on the left side in the same location.

Five millimeters below the just-described inferior horizontal division on the right parietal, just where the temporal ridge crosses, there is in the border of the frontal bone (seen with the parietal removed) a V-shaped cleft, from which leads forward and downward a peculiar suture which completely separates a portion of the frontal squama. Externally this suture is somewhat obliterated, but can be traced forward, running below the temporal ridge, on to the malar process of the frontal bone, and from here in nice serrations to a foramen situated a little more than one millimeter below the malo-frontal suture. It reappears again in the orbit running in a curve above and to the wing of the sphenoid. Ventrally the whole course of the suture can be followed without any difficulty, though in places there are signs of obliteration. The division passes downward and forward to the angle between the squama and orbital portion of the frontal bone, and then inward across this latter to the fronto-ethmoidal suture. The separated portion of the frontal bone measures 1.0 cm. in maximum width and a little over 2.0 cm. of surface length, measured ventrally. There are no radiations, and the division has the characteristics of an ordinary suture. There is no connection between this and the inferior parietal division on the same side.

The surface of the right parietal shows a slight, irregular unevenness in the middle, and some fine roughness along the superior horizontal and the vertical divisions. There is no depression in the bone. (Pl. XIX.)

Judging from the similarity of the divisions on the two sides, the vertical and superior horizontal sutures on the right side may quite safely be considered as true anomalous sutures. The wide and quite deep angle in the border of the parietal bone from which begins the cleft which is prolonged backward as the inferior horizontal suture on the right, favors the assumption that this division, also, may be a true anomalous one. The origin of the shorter division over and beyond the

middle of the right parietal I am inclined to attribute to some violence, though this opinion is based rather on the very unusual character of the divisions than on any reliable signs of an injury.

The suture in the frontal bone, equally as the incisure in the same on the left, is difficult to explain. There is no record of any similar observations, nor have I seen any other case of like nature, nor can we explain it from what we know of the development of the frontal bone. The divisions may possibly be secondary (tension) effects of the anomalous sutures, or, if the skull has suffered an injury, be the direct results of the same, their location being influenced by that of the preexisting anomalous divisions.

The surface measurements of the two parietals show the right one to be the larger, in both the antero-posterior and vertical directions:

Squamo-coronal junction to bregma	left	4.4,	right	4.7	cm.
" " " to asterion	"	4.5	"	4.4	"
Asterion to lambda	"	3.05	"	3.15	"
Antero-posteriorly at middle	"	4.75	"	5.15	"
Infero-superiorly " "	"	4.45	"	4.6	"

Case 49. *Cebus*, sex unknown, adult (basilar suture occluded, second dentition complete); No. 16288, A. M. N. H., N. Y.

The left parietal bone shows a now incomplete oblique, the right an incomplete vertical, and a trace of an oblique division.

The division on the left runs from the upper fifth of the anterior border of the parietal downward and backward, until it reaches the temporal ridge, beyond which it is entirely occluded. Upon close examination, the remainder of the division can be traced, particularly ventrally. It runs with a marked double curve from the ridge downward and a little backward to a point slightly anterior to the middle of the inferior border of the parietal. At a point 0.9 cm. from its anterior origin, the division is met by a 0.2 cm. long branch,

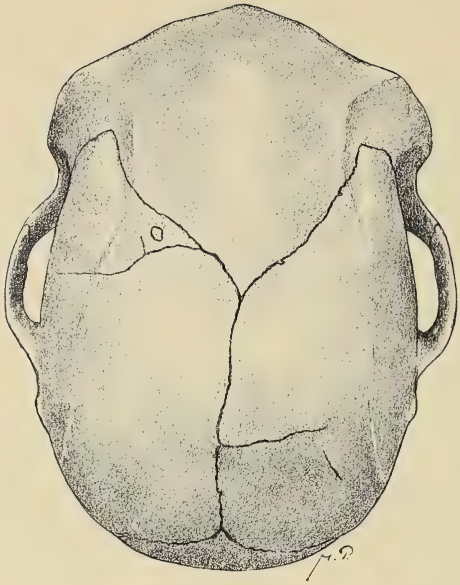


FIG. 1.

FIG. 2.

FIG. 1.—CEBUS (NO. 16,288, A. M. N. H.). BILATERAL DIVISION OF THE PARIETAL.

FIG. 2.—FELIS PARDALIS, FEMALE (NO. 11,039, A.M.N.H.). SHOWING A PARIETAL DIVISION.

the prolongation of which forward would reach the anterior border of the parietal a little above its middle; at about this point we find a small oblong foramen in the border. It is apparent that originally the parietal suture began at the summit of a deep and broad cleft. This cleft became filled with a separate bone, and the larger part of the suture between the lower border of this and the antero-inferior portion of the frontal bone became subsequently occluded. In fact, the separate piece is still completely isolated on the ventral surface of the parietal. The separate bone itself shows in middle a small, irregularly oval defect, filled with a secondary ossicle.

On the right side the vertical anomalous division begins superiorly a little beyond the middle of the sagittal border of the parietal (1.9 cm. from bregma, 1.7 cm. from lambda), runs 1.5 cm. downward, nearly parallel with the coronal suture, and then becomes obliterated. Posterior to and a little above the lower extremity of this there is a 0.6 cm. long, partly occluded segment of a division, directed downward and backward. The coronal border of this parietal bone shows two short incisures, one 0.9 cm. and the other 2.3 cm. below the bregma. (Pl. XX, Fig. 1.)

The skull as a whole is fairly symmetrical and without any signs of injuries or other anomalies. The left parietal bone is slightly higher anteriorly and posteriorly than the right one, but somewhat lower in the middle; the left parietal is also slightly shorter in its inferior two thirds than the right one.

Surface measurements of the two parietals:

Inferior end of coronal suture to bregma......	left 4.8,	right	4.65	cm.
Infero-superiorly at middle..................	" 4.5	"	5.0	"
Asterion to lambda...........................	" 2.8	"	2.6	"
Inferior end of coronal suture to asterion....	" 4.65	"	4.8	"
Antero-posteriorly at middle.................	" 5.05	"	5.1	"

Case 50. *Cebus albifrons*, male, young; No. 5050 A. M. N. H., N. Y.

The skull shows some generalized pathological condition, possibly rachitis. The bones contain an excess of organic matter, and the superior parts of the frontal and parietal

bones show many small indentations of surface and considerable pigmentation.

Each parietal presents a posteriorly somewhat incomplete division, running parallel with the squamous suture. In addition, the sagittal portion of the right parietal is divided by a vertical fissure.

Fig. 26. *Cebus albifrons* (No. 5050, A. M. N. H.), showing division of the right parietal bone.

The antero-posterior divisions, more clefts with irregular borders than sutures, begin each about 1.0 cm. above the lower extremity of the coronal suture, run across more than two thirds of the bone, and become occluded as they near the mastoid angle; if prolonged in a straight line, they would terminate in the border of this angle.

The vertical division begins superiorly 0.8 cm. from lambda and 2.2 cm. from bregma; it is patent for 1.6 cm. and runs nearly parallel with the lambdoid suture.

Case 51. *Cebus hypoleucus*, male, young; No. 11037, A. M. N. H., N. Y.

Fig. 27. *Cebus hypoleucus* (No. 11,037, A. M. N. H.), showing an antero-posterior division of the left parietal.

The skull is much pigmented and shows signs of a generalized pathological condition, possibly rachitis.

Each of the parietal bones shows a horizontal, posteriorly slightly incomplete (occluded) division. Each division is in the form of a narrow cleft with irregular borders, and with

incisures radiating into these borders. The axis of each of the divisions runs parallel with the squamous suture of the same side. The left division begins 0.8 cm., the right 1.1 cm. above the lower end of the coronal suture.

The left parietal shows also a 0.7 cm. long fissure, which passes from the lambdoid suture directly above the asterion toward the parietal eminence.

The horizontal divisions are very similar to those observed in *Cebus albifrons*, No. 5050, A. M. N. H.

The skull is symmetrical, the parietals nearly equal. No signs of injuries, or other anomalies.

Case 52. *Ateles*, sex unknown, young; No. 59, M. D., C. U., N. Y.

The right parietal bone is completely divided by an irregular vertical cleft-suture, while the left parietal shows a small anterior and a large posterior cleft-fissure both of which run antero-posteriorly, nearly parallel with the squamous suture.

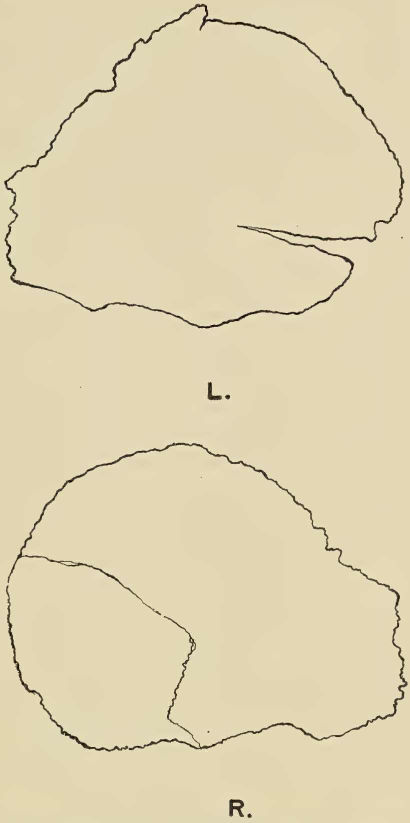


Fig. 28. *Ateles* (No. 59, Morphological Museum, Columbia University). Parietal division.

The division on the left begins sagitally near a point between the middle and posterior third of the superior border of the parietal (1.8 cm. from bregma, 0.85 cm. from lambda). It runs downward and slightly forward to beyond the eminence,

after which it bends and runs backward to within 0.5 cm. of the border of the temporal bone, when it bends again and runs forward and downward to the inferior border of the parietal. It meets the temporo-parietal suture slightly posterior to its middle. There are several oblong openings in the course of this division, and its lowest portion shows some occlusion.

In the anterior portion of the lower fourth of the right parietal bone is a 0.2 cm. long horizontal fissure.

The anterior division in the left parietal is 0.25 cm. long and directed backward and downward; it is situated 0.5 cm. above the anterior point of the sphenoidal angle. The posterior division or cleft begins distally slightly below the middle of the occipital border of the parietal, is 1.35 cm. long and directed forward and very slightly downward, running almost parallel with the squamous suture.

The skull is quite symmetrical. The bones are all very thin in spots. Temporal ridges indistinct. The left parietal bone is somewhat higher than the right one, while the length of the two is nearly the same.

Infero-superiorly at middle.................	left 4.8,	right 4.65 cm.
Antero-posteriorly at middle................	" 4.7	" 4.7 "

IV. Résumé.

Numbers. — Among the 391 Old World and American monkeys examined by me 52, or 13.3 per cent., show some form or other of anomalous parietal division. According to the species of the monkeys, the proportions of cases with division are as follows:

		Complete Divisions, alone or in combinations.	Incomplete Divisions alone.	No Divisions.
Old World Monkeys	29 Cynocephali..	0	2 (6.9 %)	27 (93.1 %)
	43 Cercopitheci..	1 (2.3 %)	0	42 (97.7 %)
	3 Chlorocebi....	0	0	3
	7 Cercocebi.....	0	0	7
	1 Colobus......	0	0	1
	190 Macaques....	15 (7.89 %)	17 (8.95 %)	158 (83.16 %)
Total.......273		*16 (5.86 %)*	*19 (6.96 %)*	*238 (87.18 %)*
American Monkeys	39 Cebi.........	0	9 (23.1 %)	30 (76.9 %)
	41 Ateles........	1 (2.44 %)	6 (14.6 %)	34 (82.9 %)
	2 Mycetes......	0	0	2
	5 Alouatas.....	0	0	5
	1 Nyctipithecus.	0	0	1
	30 Hapale.......	0	1 (3.3 %)	29 (96.7 %)
Total........118		*1 (0.84 %)*	*16 (13.56 %)*	*101 (85.6 %)*
Grand Total 391		*17 (4.35 %)*	*35 (8.95 %)*	*339 (86.7 %)*

Among the 17 previously reported cases of monkeys with complete or incomplete parietal divisions, there are 13 Old World (1 *Cynocephalus*,[1] 8 *Cercopitheci*, 3 *Macaci*, and 1 *Semnopithecus*) and 4 New World monkeys (2 *Cebi*, 1 *Mycetes*, 1 *Arctopithecus* = *Hapale*).

The Old World monkeys show in general a considerably larger proportion of complete, but a smaller proportion of incomplete, divisions than the American ones. If we count all the divisions together, their proportions in my two series of cases (there are no data as to the number of cases examined in other instances) are almost equal (12.8 % in the Old World, 14.4 % in the American monkeys); but such a combination and comparison are not fully justifiable: they would imply an equivalence of the divisions which cannot thus far be clearly proven.

The *proportion* of the anomalies under consideration differs quite markedly in the various species of monkeys. Divisions of various nature are comparatively very frequent in the Macaques, particularly the *Macacus rhesus*, and quite frequent in the *Cebi* and *Ateles*, but rare in the largest and smallest monkeys inspected, namely, the Cynocephals and Marmosets.

Age. — With a few exceptions all the instances of parietal division in monkeys were found in the young or adolescent animals; even in these cases, however, the anomalous division was often seen to present greater or lesser signs of occlusion, thus showing a lesser stability than that of the regular sutures. There is no example in the monkeys of a whole or even a part of an anomalous parietal suture persisting after occlusion has much advanced in the normal parietal articulations.

Sex. — Contrary to what is found in man, in monkeys the females are well represented among the individuals with parietal divisions. In fact, they surpass the males in a proportion of 2 to 1 in the category of complete sutures, but are in turn surpassed by the males, in nearly the same proportion, in the class of incomplete divisions. Counting all the divisions, the proportions of the same in the two sexes are very nearly

[1] Maggi (63) mentions another case of parietal division in a "*Papio Mormon*," but gives in that place no particulars.

equal. It is not impossible that the smaller proportion in the males of complete, and a larger one of incomplete, divisions is due to the fact that in the majority of the male skulls with the anomaly, obliteration of the anomalous sutures has from some cause advanced further than was the case in the majority of the female skulls with parietal divisions.

The coincidence of unequal proportions of the anomalous divisions when separated into complete and incomplete ones, and the equalization of these proportions when such a distinction is abandoned, in the case of the males and females as well as that previously considered of the Old World and American monkeys, is remarkable and opens an interesting little field for further investigation.

The following table gives the details of the proportions of the complete and incomplete divisions in my cases, in the two sexes:

OLD WORLD MONKEYS.

	Number Examined.	Complete Divisions (between any two borders of the parietal), alone or in combinations.	Incomplete Divisions, alone.	No Division.
		Cynocephali.		
Males	2	0	2	0
Females	—	—	—	—
Sex unknown	27	0	0	27
	(29)	(0)	(2)	(27)
		Cercopitheci.		
Males	—	—	—	—
Females	1	1	0	0
Sex unknown	42	0	0	42
	(43)	(1)	(0)	(42)
		Chlorocebi, Cercocebi, Colobus.		
Sex unknown	11	0	0	11
		Macaci: M. rhesus.		
Males	35	3 (8.57 %)	2 (5.73 %)	30 (85.7 %)
Females	31	4 (12.9 %)	2 (6.4 %)	25 (80.6 %)
Sex unknown	64	7 (10.9 %)	9 (14.1 %)	48 (75.0 %)
	(130)	(14)	(13)	(103)
		M. cynomolgus.		
Males	—	—	—	—
Females	1	1	0	0
Sex unknown	9	0	0	9
	(10)	(1)	(0)	(9)
		M. erythræus.		
Sex unknown	8	0	3 (37.5 %)	5 (62.5 %)

	Number Examined.	Complete Divisions (between any two borders of the parietal), alone or in combinations.	Incomplete Divisions, alone.	No Division.
		M., various undetermined species.		
Males..........	—	—	—	—
Females........	1	0	0	1
Sex unknown...	41	0	1	40
	(42)	(0)	(1)	(41)
		Total of Macaques.		
Males..........	35	3 (8.57 %)	2 (5.73 %)	30 (85.7 %)
Females........	33	5 (15.15 %)	2 (6.06 %)	26 (78.8 %)
Sex unknown..	122	7 (5.747%)	13 (10.65 %)	102 (83.65 %)
	(190)	(15)	(17)	(158)
		AMERICAN MONKEYS.		
		Cebi.		
Males..........	1	0	1	0
Females........	—	—	—	—
Sex unknown...	38	0	8	30
	(39)	(0)	(9)	(30)
		Ateles.		
Males..........	12	0	12	0
Females........	—	—	—	—
Sex unknown..	38	1	3	34
	(41)	(1)	(6)	(34)
		Hapale.		
Sex unknown...	30	0	1	29
		Mycetes, Alouatas, Nyctipitheci.		
Sex unknown...	8	0	0	8

TOTALS.

	Number Examined.	Complete Divisions, alone or with others.	Incomplete Divisions, alone.	Total of Cases with Divisions.	No Divisions.
Males..........	41	3 (7.3 %)	7 (17.1 %)	10 (24.4 %)	31 (75.6 %)
Females........	35	6 (17.14 %)	3 (8.57 %)	9 (25.7 %)	26 (74.3 %)
Sex unknown...	315	8 (2.54 %)	25 (7.94 %)	33 (10.48 %)	282 (89.5 %)
	(391)	(17)	(35)	(52)	(339)

The sex was not reported in any of the previous 17 records.

Direction. — Among the total 69 monkeys with parietal divisions now on record, including the above, there are 36 in which the anomaly is bilateral and 32 in which it is unilateral; or, counting the separate parietal bones, there are, out of a total of 138 of these, 105 with, and 33 without, divisions.

The total number of individual divisions amounts to 133, and of these there are:

15	instances	of	complete vertical (infero-superior) suture;
51	"	"	incomplete " " " "
3	"	"	complete division running from the sagittal suture to the mastoid angle;
4	"	"	incomplete division running from the sagittal suture to the mastoid angle;
Total, 73	*instances of more or less vertical divisions.*		

4	instances	of	complete antero-posterior suture;
40	"	"	incomplete " " "
Total, 44	*instances of more or less horizontal divisions.*		

8	instances	of	complete oblique suture;
8	"	"	incomplete " "
Total, 16	*instances of oblique divisions.*		

The previously published observations on monkeys, included in the preceding summary, comprise 6 complete and 8 incomplete vertical, 2 complete and 7 partial horizontal, 1 sphenoidal angle-lambda, 1 sphenoidal angle-sagittal suture, 1 middle of coronal to middle of sagittal suture, and 1 superior part of coronal to inferior part of lambdoid suture divisions. Altogether we have then in monkeys, known to date,

73	instances	(55. %)	of more or less vertical,
44	"	(33. %)	" " " " horizontal, and
16	"	(12. %)	" oblique divisions.

The preponderance of the vertical over all other divisions is very evident, and constitutes one of the most interesting results of my examinations. We will return to these data in the succeeding chapter.

Location. — Among the 106 parietal divisions in my 52 cases, 56 (33 vertical, 17 horizontal, 5 oblique) are on the right and 50 (26 vertical, 18 horizontal, and 6 oblique) on the left side; which is a pretty even distribution. Among the previously known 27 divisions 15 were on the right, 11 on the left side, and 1 ? The total: 71 instances (53. %) in the right and 61 instances (47. %) in the left parietal. The difference in the two sides is too small to be of much significance.

Of the incomplete vertical divisions a very large majority is found in the superior portion of the parietal, and particularly in the posterior four fifths of this portion.

Of the 40 incomplete horizontal divisions, 25 are in the anterior and 14 in the posterior portion of the parietal bone, (1 ?), and communicate respectively with the coronal and lambdoid sutures.

Of the minor oblique divisions, 2 separate the tip of the sphenoidal angle; 1 runs from the posterior to the inferior border; and 1 is situated in the anterior, 1 in the superior, 3 in the postero-superior, 3 in the posterior, and 1 in the postero-inferior portions of the parietal.

Size of the Parietals. — Where both parietal bones are divided in a similar manner, the size of the two bones is generally very nearly equal; where the division is unilateral, or bilateral but dissimilar, the size of the bones generally differs. The presence of a division is probably, as a rule, a feature favorable to the growth of the bone with the anomaly, particularly to a growth in the direction at right angles to the division, which agrees with the well-known law of growth of the bones under similar circumstances in man. There is noticeable in the monkeys a lesser regularity and lesser prominence of the differences in growth than is usually found in man; this is undoubtedly partly due to the smaller dimensions of the bones in the monkeys and partly, probably, to a frequent earlier presence of a bilateral division.

The following table shows the relative proportions of the parietals in which but one parietal showed a division:

Case. No.	Parietal Divided.	Nature of Division.	Right Parietal Exceeds in:	Right Parietal is smaller in:
29	left	incomplete inferior vertical	hight, length at middle	length, inferiorly
36	left	incomplete posterior horizontal	length	hight, especially posteriorly
3	right	incomplete superior vertical	length	hight
24	right	incomplete inferior vertical	length, hight anteriorly	hight posteriorly
26	right	incomplete inferior vertical	length, hight	—
19	right	vertical (partly occluded)	length, hight	—
14	right	incomplete vertical	hight	length at middle slightly
28	right	incomplete inferior vertical	length, hight at middle	hight posteriorly
44	right	incomplete horizontal and incomplete vertical	length	—

Asymmetry. — While minor irregularities in form, determinable mostly only by measurements, are common in monkeys with parietal divisions, the more marked asymmetries, amounting to plagiocephaly, such as occur very frequently under similar circumstances in man, are very rare. Here again we must consider the naturally small size of the monkey parietals on which asymmetries are less visible than on the considerably larger human bones. It is very probable, however, that in man there is felt more than in monkeys the influence of an additional factor in producing an excess of growth in the divided parietal, and thus leading to asymmetry of the cranial vault, which factor is the more rapid and longer continued brain growth.

Pathological. — The monkey skulls with parietal divisions which I examined are almost absolutely free from pathological conditions. The only exceptions to this are the skulls of two young *Cebi* (Cases 50 and 51), which show what is probably a generalized rachitic condition. Hydrocephalus is a condition that is either absent or excessively rare in monkeys, and no one of the specimens with divisions shows the slightest traces of it.

Intercalated Bones; Early Normal Divisions. — There is no indication that intercalated bones, comparatively rare in monkeys in general, are more frequent in the skulls with divided parietals; and the same may be said of metopic and other earlier normal sutures. Not one of my specimens with a parietal division, and only one of those described by others (*Cercopithecus*, Coraini), has a fully preserved metopic suture, though one or both terminal portions of the same are common in the younger subjects.

Characteristics of the Anomalous Divisions. — The complete or longer parietal divisions in monkeys show generally more or less the character of a suture. Many show more or less of a serration, which usually approaches in type that of the regular sutures. Besides the superficial serration, the divisions show often a tendency to a squamous arrangement, and some are distinctly of a squamous nature. Among these in cases 18, 21, 22, 25, and 46, the border of the anterior over-

lapped that of the posterior; in case 47 the border of the posterior overlapped that of the anterior; and in cases 47 and 31 the border of the inferior overlapped that of the superior portion of the divided bone.

Occlusion. — As a general rule, to which there may be some exceptions, the anomalous parietal divisions in monkeys tend to an earlier synostosis than the normal articulations of the parietal. They are also affected by a relatively earlier synostosis than is the case with similar divisions in man, which probably stands again in connection with the differences in the growth of the brain.

The preceding data show, in the main, that anomalous parietal divisions are much more common in monkeys and apes, particularly in certain species, than they are in man; that they occur with about the same frequency in both sexes and offer a much greater variety than in man; that divisions of a certain kind, particularly such as run more or less parallel with the coronal and lambdoid sutures, while extremely rare in man, are quite common in the monkeys; that the divisions in the monkeys give rise to relatively lesser deformities of the cranial vault and are subject to a relatively earlier occlusion than those in man; and that pathological conditions of the skull play apparently no rôle in the production or sustenance of the divisions in monkeys; all of which conditions are undoubtedly of some importance in the study of the phenomenon of parietal divisions in general.

V. Parietal Divisions in Mammals Lower than the Monkeys.

In more than two thousand adolescent and adult crania of various mammals lower than monkeys, which I inspected within the last six years, I found but one with a major, and two with minor, complete parietal separations. These will be the first cases on record, which is proof of the great rarity of this sort of anomalies in the parietal bone in adolescent and adult mammals below the monkeys.

The major separation consists of a complete vertical-oblique suture in the right, and an incomplete similar suture in the left parietal of an adolescent ocelot. The minor cases are a separation of a portion of the mastoid angle of one of the parietals in a puma, and a separation of a portion of the sphenoidal angle in a seal and a deer. In detail these cases are as follows:

Felis pardalis (No. 11039, A. M. N. H.), male, adolescent.—The skull shows no signs of injuries and no anomaly besides the parietal divisions. No Wormian bones.

Both parietals are affected by what is apparently an anomalous division. Both divisions begin at the same point from the sagittal suture, 1.6 cm. posteriorly to the bregma and 2.2 cm. anteriorly to the lambda.

On the right parietal the anomalous suture passes from the superior border at first for 1.3 cm. downwards, and then, after a bend, downward and forward, to end in the posterior extremity of the sphenoidal border of the parietal, directly opposite the temporo-sphenoidal suture. The anomalous suture shows on both sides a moderate serration and is patent.

On the left parietal the division is incomplete. It proceeds for 8 mm. nearly parallel with the vertical axis of the bone, after which it becomes much less distinct, curves slightly forward, and is lost near the well-marked temporal ridge. (Pl. XX, Fig. 2.)

Measurements of the two parietals show the following differences:

Antero-posterior arc at middle	left 3.8,	right 3.6 cm.
" " " temporo-sphenoidal point to asterion	" 2.6	" 2.55 "
Hight, temporo-sphenoidal point to bregma	" 3.4	" 3.65 "
" at middle	" 3.3	" 3.15 "
" asterion to lambda	" 2.35	" 2.35 "

The left parietal, according to these measurements, is slightly longer and higher at middle than the right parietal, this latter being higher anteriorly. The actual area of the two bones does not show much difference, and the skull is not appreciably asymmetrical.

There are, as already mentioned, no signs of injuries on the skull. The normal sutures show the first traces of ossification.

Felis concolor (No. 5034, A. M. N. H.), adolescent, sex unknown.— The right parietal bone shows a separation of a portion of its postero-inferior angle by a 1.5 cm. long, slightly serrated suture, running straight between the posterior and inferior parietal borders. No other anomalies, no signs of injury. No intercalated bone or a separation in same location in 14 other pumas.

Dorcelaphus hemionus (A. M. N. H.), adolescent, sex not determined. — The right parietal shows a separation of the extremity of its sphenoidal angle. Nothing similar in 10 other *Dorcelaphi*, but a slightly incomplete separation of like nature in a *Phoca fœtida*.

There are in the American Museum numerous skulls of various species of South American rodents of the genera *Ctenomys* and *Lagidium*, every one of which skulls presents at the asteric angle a comparatively large, regular, quadrate (more often) or triangular bone. This bone, which apparently is characteristic of these species, is either a regular fontanel bone or a separation of the postero-inferior angle of the parietal. The former of these suppositions seems more probable, but the point can only be settled by further observations, particularly on the young of the species.

For *fissures* in the parietal bone in mammals below the monkeys *v.* detail chart at the end of the chapter on 'Divisions to Foramina.'

VI. Pathological and Accidental Defects and Divisions in the Parietals.

This category of cases will be noticed only because some of the defects and divisions present at times forms which it is difficult to distinguish from the normal or anomalous parietal separations.

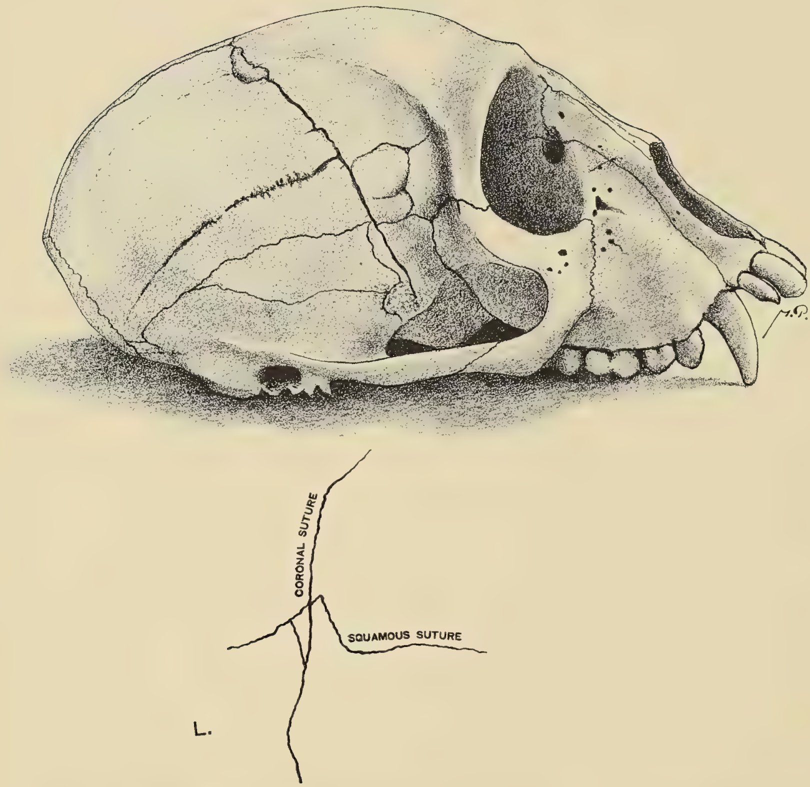
The pathological defects in the parietals occur as irregular, large perforations; smaller rounded or oval perforations; and

circular or oblong foci, which, sieve-like, are full of minute perforations or pores. The proper diagnosis of these defects can but rarely present much difficulty; they may, however, coexist with other divisions and be separable with less facility.

Effects due to mechanical influences appear on the parietal bone as simple or radiating fissures, and as more or less complete and suture-like, simple or branching, lineal, or, much more commonly, irregular separations. In some of these cases a differential diagnosis of the division from a normal or anomalous fissure or suture is very difficult and may be impossible. The circumstances which in doubtful cases would favor the recognition of a division or a fracture are (already partly mentioned when the very oblique and infero-posterior sutures were considered): signs of a cranial injury, especially when in connection with the division; irregular course, branching, one-sidedness, incompleteness, and a very unusual location of the division; and its extension into neighboring bones. As contributive signs of secondary importance in favor of a fracture may be considered an absence in the division of Wormian bones, separation of the borders of the bone along the division, bluntness of the borders, and callus formation. No one of the above signs of differentiation is alone decisive, and with all of them in mind we will still meet with cases which shall baffle our efforts at a distinction of the division. The following instance shows a fracture of the parietal which, though recognizable, offers nevertheless a considerable similarity to a sagittal parietal suture.

Case *α*. *Cercopithecus fuliginosus*, nearly adult; No. 2065, A. M. N. H., N. Y.

The lower part of the squama of the frontal bone on the right side shows the signs of a considerable injury. Apparently the bone was fractured, and two pieces, the superior of which was quite large, were separated, but have since reunited together and with the frontal bone. One of the breaks extended forward to the temporal ridge. The superior wall of the orbit shows two larger and several pin-point defects. The fronto-parietal articulation on each side appears as if it had been forcibly spread, and the coronal suture extends straight



Cercopithecus fuliginosus (No. 2065, A. M. N. H.). Parietal Suture or Fracture (?).

downward, separating the anterior extremity of the temporal squama on the left and a portion of the wing of the sphenoid on the right. The surface of the sphenoid and temporal bone, below the termination of the prolongation of the coronal suture on the right side, shows fine superficial porosity.

Besides the thus far mentioned effects of the injury we see on the right side a temporal and a parietal division. The temporal division begins at the extended coronal suture, 1.1 cm. below the squamo-coronal junction, and, passing backward and upward, terminates a little posterior to the middle of the squamous border. Though plainly traceable, this division is well on the road to occlusion.

The parietal division begins 1.1 cm. above the squamo-coronal junction and 0.2 cm. above the external mark of the superior fracture of the frontal bone. It runs downward and backward to within 0.55 cm. of the squamous suture, and then almost directly backward to a point 0.4 cm. above the asterion, terminating a short distance anterior to the lambdoid suture. The division is not squamous nor serrated; the borders of the two portions of the parietal bone lie simply in apposition. Parts of the division show occlusion and very slight superficial signs of inflammation (roughness, deposition of new bone, fine porosity).

In the superior portion of the right coronal suture, 0.25 cm. from bregma, is a quite large Wormian bone, formed almost entirely at the expense of the parietal.

The skull is symmetrical. The right parietal bone is higher anteriorly and at middle, but lower posteriorly, than the left one, while the length of the two is very nearly equal. The parietal division, other lesions excluded, could very easily be taken for an anomalous suture. (Pl. XXI.)

VII. The Causes of Anomalous Parietal Divisions.

The original condition which makes the "typical" complete anomalous division of the human parietal bone possible is, as is to-day probably generally acknowledged, the existence of more than one center of ossification of the bone. These

centers, which ordinarily unite and form one bone, persist in rare instances in their separation and give rise to a parietal composed of two or more portions, similarly as happens sometimes in the human malar.

The theory of the development of the parietal bone in man regularly from two centers, and the ensuing elucidation of the origin of the typical parietal division on this basis, is due almost entirely to the researches of Toldt (1882–83) and Ranke (1899). Before Toldt it was a generally accepted opinion that the parietal bone develops from one center, and the origin of a parietal suture was a matter of speculation. Soemmering (8) recognized it to be of congenital origin. Certain expressions of Hyrtl (50), Gruber (25, pp. 12–15), and even Welcker (17, p. 109) make it probable that all these observers suspected that the original cause of the divided parietal is a presence of a double center of ossification of the bone, but neither author has made a definite statement on that point. In fact Welcker later on, as already mentioned (55), declared a development of the parietal from more than one center inadmissible. Hyrtl, in particular, reflected more upon a relation between the temporal ridges and the parietal suture than on that between this and a greater number of the centers of ossification. Calori (20, p. 341) attempted to explain the divisions in the cases that came under his observation by the theory that in the apparently divided parietals the additional portion of the bone was developed from an accessory portion of the ossifying parietal that became isolated and failed to unite with the real center of ossification because of an abnormal distention of the cranial vault.[1] Coraini, considerably later (1893) and after Toldt's work, advanced, partly in agreement with Calori's view, the hypothesis that in the apparently divided parietal one portion of the bone is the real parietal and the other is an accessory one, closely allied in nature with the Wormian bones (33, pp. 140–144; *v.* following foot-notes).

[1] "Quindi la circonferenza esterna, o l'inferior-anteriore del germe osseo dei parietali non potendosi assimilare la sostanza ossea depositantesi al di fuori di lei, e rimanendo tale sostanza sciolta e libera e dilungandosi per la distensione via via crescente dal germe cui doveva servire ad augumento, resasi indipendente ha fato di sè centro di ossificazione a sè stessa, e si è costituita in osso distinto, separato dal germe osseo proprio a' parietali," etc.; *v.* also the following foot-notes.

Maggi and Frassetto, finally, advanced, as already mentioned in the introductory chapter, the theories of respectively three- and four-center origin of the parietal.

Toldt's investigations concerned the regular development of the normal human parietal bone, and the explanation of the formation of a divided parietal was an inference based on the results of that research. The author expresses himself in the following language (48): "The ossification of the parietal begins in the 10th week of the embryonal life. It commences in the form of a wide-meshed net, composed of slender laminæ of bone. During the 11th to 13th week this net shows the formation of two, superimposed, more dense centers. The laminæ of bone radiate from each of these centers and meet on the opposed portions of the periphery of the two sets. In some cases the radiate arrangement is less pronounced in one than in the other center. Both centers unite gradually during the 4th month, nevertheless their former separation is still marked by a more or less deep anterior and posterior cleft in the bone. In the 5th month the development of the parietal eminence takes place, in the situation where the two centers have met. There are, in consequence, in opposition to the commonly accepted opinion, two well-distinct, even if not completely separated, points of ossification for the parietal bone. This makes it possible to explain the occasional sagittal suture in the parietal bone."

In 1883 (49) Toldt supplemented the above statement by further explanation and by an illustration, showing a case with two clearly marked, though not fully separated, parietal centers.

Since Toldt the theory of a two-center development of the divided as well as the undivided parietal has been gaining a gradual recognition (Putnam, Turner, Coraini, Dorsey, O. Schultze, Graf von Spee) until 1899, when it received an important corroboration by the work of Ranke (36). Before the work of this author, however, there appeared in 1896 and 1897 (59, pp. 900, 901, and 60, p. 1165 *et seq.*) the contributions of Maggi, who declared, basing his conclusion on his observations on human fœtuses, that the human parietal

develops from three centers, but that even four centers of ossification may be encountered.[1] Of the three centers two may fuse early and leave but two separate. The formation of these different centers is *posterior* to that of the unique center that appears about the 45th day of fœtal life. According to this the ossification of the parietal would start about the 6th or 7th week of intrauterine life from one focus, but a little later on there would appear two, or more rarely three, additional centers. Thus far this theory has not been substantiated by any other author, though it is utilized by Frassetto; but it must be remarked that, with the exception of Ranke, no author since Maggi has made any extensive embryological inquiries into the matter.

Ranke's researches extended over some embryological material on which he found no such centers as announced by Maggi (he does not mention Maggi's work), but conditions similar to those announced by Toldt, that is, an early and usually brief, but apparently regular, existence of two foci of ossification for the parietal. Following with investigations on older subjects, Ranke shows that more or less marked traces of the original two portions of the parietal are, in man, common at birth, and can occasionally be detected even much later in life; and that similar, only still more marked and longer-lasting signs of a similar condition can be seen on the skulls of apes, particularly the orangs.

But Ranke's conclusions also differ in several details from those of Toldt. In Ranke's words (36, p. 52): "My tests of Toldt's teachings have resulted in a complete agreement in the main points of our observations. There is, however, one point in which I must go further. I find that we have not simply 'two to a certain degree independent centers of ossification,' but that: *The human parietal bone is a complex of two embryonal, separated, superimposed, elementary bones of*

[1] 59, p. 900: "I centri di ossificazione dei parietali, che finora potei chiaramente vedere in feti umani da 2 mesi e mezzo a 3 mesi e mezzo, sono tre per ciascun osso. Talora di questi tre centri, sempre in feti dello stesso tempo di sviluppi suindicato, due si uniscono in un solo e si hanno allora soltanto due centri di ossificazione per parte. La formazione di questi diversi centri segue a quella, ammessa dagli antori, di un punte unico di ossificazione per ciascun parietale, che appare verso il 45° giorno di vita intrauterina, e precede quella della gobba parietale."

[2] 60, p. 1167: "Quatro centri di ossificazione per ciascun parietale, che talora si vedono nei feti umani," etc.

the skull, which unite only during the later progress of development."

"The occurrence of the horizontal division of the parietal bone results, as established by Toldt, from an individual development of the two portions of the bone." "The parietal is a complex of two elementary bone-individuals, whose separation can from certain causes persist just as well, even if less frequently, as the frontal suture, the embryonal separation of the two frontals" (p. 56).

The parietal eminence is "formed from the fused centers of ossification of the upper and lower parietal," "and not at the point of the former dividing line of the two centers" (pp. 55, 56).

"The form of the parietals shows in all the new-born, as well as older products in our race, traces of the former division of bone by a parietal suture into an upper and a lower parietal" (p. 29).

The principal observations upon which Ranke based his conclusions are as follows (36, pp. 52–56, figs. 29–32):

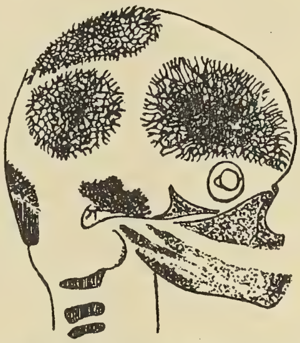


Fig. 29. Head of a Human Embryo, showing two separate parietal centers of ossification. (After Ranke.)

1. An embryo 6.5 cm. long shows the upper and lower parietals fully developed, but still completely separated. (Fig. 29.)

2. An embryo of 9.0 cm. total length shows also a still complete separation of the upper and lower parietals; but there appear to be differences in the position and size of the elementary bones.

3 and 4. In two embryos of respectively 10.0 and 11.0 cm. length, the two original centra of the parietal bone are united, but their existence is still recognizable and traces of their union are still patent.

5. An embryo of 12.0 cm. length showed similar conditions as the preceding. (Fig. 30.)

These cases show very plainly the formation of the human parietal from two superimposed foci and there is no trace of

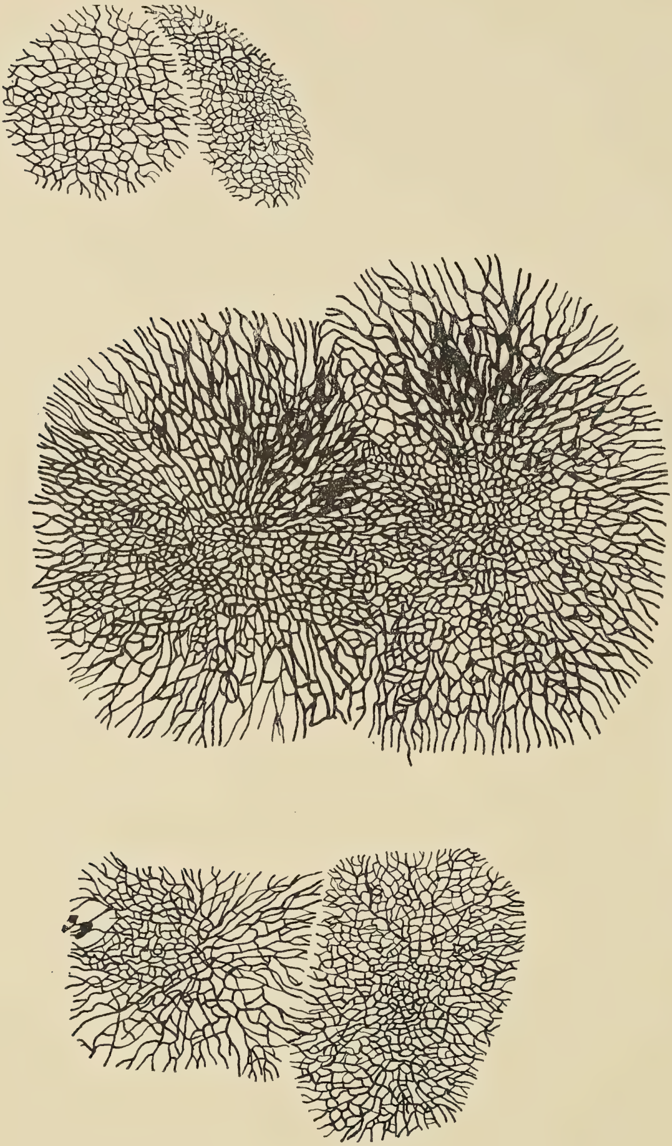


Fig. 30. Embryonal Parietal Bones, showing two centers of ossification. (After Ranke.)

such a condition as is mentioned by Maggi. It is difficult, however, to accept as demonstrated Ranke's view that these foci represent or are two distinct parietals, for we meet with similar foci in all the cranial and facial as well as all the other bones of the skeleton, and we should have to assign to all a similar morphological value. We shall return to this view later. The essential point which concerns us in this place, and which Toldt's and Ranke's investigations seem to establish, is the real manner of the development of, particularly, the human parietal bone, which enables us to comprehend the formation of the anomalous parietal divisions, particularly the "typical" horizontal parietal divisions.

Frassetto's four-center theory (70) needs scarcely more than be mentioned; it lacks a proper substantiation.

Toldt's and Ranke's, and we may include Maggi's, researches explain the original condition which makes the anomalous parietal divisions, at least those of a certain sort, possible; the plain fact of the original existence of two (or even more than two) separate centers of ossification does not, however, reveal, and, in fact, has hardly any relation to, the *actual* cause or causes of the persistence of the separation of these centers. This persistence requires, as Ranke well says (p. 27), "an additional individual cause, without which such 'supernumerary' sutures would not be found in the adult crania."

What that *determining* cause or causes may be is still largely a matter of conjecture. Calori,[1] and after him Coraini,[2]

[1] 20, p. 338 *et seq.:* The parietal bone develops from one unique center of ossification, and in consequence of that, the mode of formation of a division in the bone must differ from that of the frontal, squamo-mastoidal, or transverse occipital suture. "Ci possiamo però valere delle altri condizioni, cioe dello svilupparsi ed aumentarsi od ampliarsi del cervello e della capsula cranica o normalmente, o per ipotrofia di esso, ovvero per idrocefalo, sproporzionatamente allo sviluppo ed incremento delle ossa. Posto dunque che il cervello cresca sproporzionatamente, o vi abbia idrocefalo, e la capsula predetta consentendo al contenuto si dilati, dee necessariamente sonseguitare che il processo ossificante si rallenti sì per la compressione come per la diversione di una parte di materiali nutrizi da esso lui, materiali che a se attrate il cervello, o l' idrocefalo che cresce a sue spese. Per questa scarseggiante nutrizione gli spazi membranosi interposti ai punti di ossificazione od alle ossa che essi compongono, rimarranno molto estesi; anzi si estenderanno vieppiù in forza della distensione. I punti ossei poi crescendo e dilatandosi per l'aggiunta di sostanza ossea alla loro circonferenza non avranno in virtù della forza distendente molta agevolezza di appropriarsela, anzi ne saranno impediti, per forma che rimarrà ella libera e si dilungherà da essi, e ci apparirà, come non di rado, sotto forma di isolette in quegli spazi membranosi, le quali cresceranno in wormiani, e radoppieranno le suture, od in forza della sinostosi congiugerannosi e comporrannoi in un osso solo, che più tardi si articolerà per suture con le ossa vicine." *Seq.*, pp. 340, 341.

[2] 33, p. 142 *et seq.:* "La causa di questa serie di fenomeni e della divisione quidi dell parietale ritengo, con Calori, che debba essere considerata una sproporzione fra l'accrescimento del contento cranico e l'accrescimento delle ossa del cranio, di tal maniera

search for such an influence in a disproportion, due to physiological or pathological causes, between the growth of the cranial contents, in favor of these, and the cranial, especially the parietal, bones. The disproportion may be due either to physiological (rapid growth of brain) or pathological causes (hydrocephalus). Coraini further sees in the phenomenon a tendency to an appearance of a new bone, an example of neomorphism.

Maggi, as already referred to under 'General Remarks,' considers the divided parietals homologous with the multiple parietal scales in stegocephali, etc. This comparison seems to imply that the anomaly in the human parietal is reversive in nature.

There is no further expression of opinion on the determining cause of the parietal divisions except by Ranke. This author's view, that the two foci from which the parietal develops represent two independent parietal bones, would seemingly tend to approach the parietal sutures to examples of neomorphism. Ranke, however, expresses another theory, which is as follows (36, pp. 27–28): "It has long since been established by Virchow that the so-called supernumerary sutures are very often observed in company with prematurely synostosed normal sutures. It can be imagined that the pressure of the growing brain against the cranial vault, meeting with an abnormal resistance in the locality of the premature synostosis, expands more strongly those parts of the vault, such as bones divided by a suture, at which it meets with a lesser resistance, and thereby hinders the normal closure of those fœtal sutures and fissures that are still open. The earlier this normal process of closure in fœtal life tends to be effected, the more rare will be the corresponding supernumerary sutures in the adult."

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da fare sisentire la sua influenza specialmente nell' ambito dei parietali, i quali per ciò non possono da soli completare la corrispondenta parte della scatola cranica."

P. 144: If confirmed, "l'anomalia rappresentarebbe dunque un fatto, che potrebbe dirsi de neomorphismo; rappresentarebbe una variazione che tende a fissarsi e che porta formazione di un nuovo osso, il parietali accessorio, il quale sarà nei singoli casi o unico o multiplo."

P. 144: "Ma in ogni singolo cranio essa potrà avere inaltre un altro e speciale significato, potrà rappresentare un carattere di superiorità, nel senso antropologico, qualora la sproporzione, indicata come causa della sua comparsa, sia dovuta ad un aumento della massa cerebrale conginuto a superiorità di attività psichica; oppure rappresenterà un carattere patologico, qualora tale sproporzione sia prodotta da una conditione patologica."

We shall return to most of the just-mentioned theories of origin and causation of parietal divisions later. What needs to be remarked in this place is that they all, except those of Maggi and Frassetto, apply principally to the *complete typical* antero-posterior divisions. These are, however, not the only divisions which occur even in the human parietal.[1] There have been observed also some very oblique divisions crossing the whole bone, and others, oblique or angular, which separate one, usually the mastoid, angle of the bone. About the nature of these *atypical* and *minor* divisions there is considerable uncertainty. Welcker apparently considered the minor as equivalent with the major sutures. He says (17, p. 109): "I know a number of skulls on which can be seen a suture beginning at the middle of the lambdoidal margin of one of the parietals and passing over this bone; but this particular suture, instead of halving the parietal, bends towards the temporal border, separating only the mastoidal angle of the bone. The separated piece has the appearance of a large intercalated bone. When the separated lower segment is equally as large as the upper part, as in a horizontal division of the whole parietal bone, the term intercalated bone (Schalt oder Nahtknochen) is not applicable to either of the pieces; yet the process of production of the two segments, when of equal size, must have been exactly the same as in the case where pieces of unequal size have resulted." Gruber, in describing an instance of a separation of the mastoid angle (25, pp. 12–15) calls the separate postero-inferior portion a "parietale secundarium posterius," which term gives that portion a similar morphological value with the larger antero-superior bone, and approaches the suture dividing the two to the typical antero-posterior anomalous suture. Putnam (26), speaking of the postero-inferior (as later shown, inferior) segment in his second Tennessee specimen, considers this as developed from "a separate center,".which also tends to give the anomalous suture a similar value to that of the typical antero-posterior one. For Toldt (49, p. 86) the very oblique antero-posterior

[1] The material in apes and monkeys being almost wholly very recent must be excluded from these and following notes; these should be understood to apply solely, unless specified otherwise, to the human parietals.

sutures of the parietal had the same significance with the typical horizontal ones, and were due to a preponderance of growth in one of the centers of ossification. For Coraini, the divisions that separate only an angle of the parietal bone have practically the same significance as the divisions that halve the bone,—they are all accessory bones, allied to the Wormians formed from accessory centers of the parietal. The restriction of the division to one angle may be explained either by a later appearance or lesser growth of the accessory center; or, even more probably, by the supposition that there were originally two superimposed accessory centers, and possibly formed portions, as in the case of Fusari, one of which, however, united early with the main portion of the bone or the real parietal. The nature of the sutures, transverse, oblique, or vertical, depends on the relative position of the centers from which the particular parietal is developed.[1] Maggi, with his three- or even four-center theory finds naturally an easy explanation for all forms of division of the parietal; and so does Frassetto.

For Graf Spee (51), "the typical development of the parietal bone from two centers does not afford any explanation for those fissures which divide the planum temporale of the bone." "It is possible that the portions of temporal squama and those

[1] 33, p. 140 *et seq.:* "Io penso che la divisione del parietale possa essere intesa nel modo seguerite: Quando il parietalo sorge anormalmente da due punti di ossificazione, si potrà avere una delle prime quatro (α, β, γ, δ) varietà di divisione dell' osso; si avrà cioè un parietale bipartito da una sutura soprannumeraria, l'audamento della quale, trasversale, verticale, o variamente obliquo, dipenderà dalla posizione reciproca occupata dai due germi del parietale al loro insergere e dal vario potere di accrescimento che ognuno di essi verrà manifestando nella contesa, direi, dello spazio.

"Anche le due successive varietà (ϵ, η) di parietale diviso per separazione dell' angolo mastoideo pare che possano ripetere il medesimo meccanisimo. Il parietale deriverebe egualmente da due germi di ossificazione, uno di quali però sarebbe sorto molto eccentricamente cioè nell ambito di uno dei detti angoli parietali, ed inoltre o sarebbe sorto tardi rispetto al' altro, o sarebbe stato dotato di minore attività formativa.

"Senza escludere questa maniera di prodursi delle due dette varietà, parmi si possa pensare ancora ad un meccanismo diverso, e mi dimando: é possibile che in questi casi si tratti di parietali sorti, come nel caso di Fusari, da tre germi d'ossificazione? Ammettendo una precoce sinostosi fra il germe anteriore ed il posterior-inferiore si comprenderebbe la divisione del parietale per separazione dell' angolo occipitale; ammettendo la sinostosi fra il germe anteriore ed il posterior-superiore, si comprenderebbe la divisione del parietale par separazione dell' angolo suo mastoideo; ammettendo la sinostosi del germe posterior-superiore coll' anteriore e col posterior-inferiore si comprenderebbe la divisione del parietale per separazione incompleta dell' angolo suo mastoideo mediante una breve sutura soprannumeraria verticale come nei casi di Gruber e mio."

This latter hypothesis has the advantage over the former, "che l'origine del' parietale da tre germi è un fatto (si pure una sola volta) constatato e che essa ha il vantaggio di darci ragione della forma e della grandezza del pezzo del parietale separato, dell' audamento della sutura anomala, e ci permette di spiegare facilmente tutte i singoli casi compressi nelle due dette varietà."

of the lower part of the parietal which are separated by these extremely rare fissures can be referred to the Wormian bones (Schaltknochen)."

Ranke's opinion as to the sutures that separate only an angle of the parietal differ from all the preceding (36, pp. 33–35) is, that the separations of the mastoid angle "possess something decidedly typical." Nevertheless I should not fully agree with Putnam's supposition that in these conditions we have to deal with a primarily "separate center." "Yet, the oblique and the sagittal parietal suture, cutting into the parietal from the same point (posteriorly), have something in common in development."

Ranke considers Putnam's case as similar to his three cases of an incomplete sagittal suture, and on this assumption (incorrect in view of the more detailed description of the case here given) bases the following conclusion: "When we accept that the (posterior) incomplete horizontal resp. sagittal parietal suture and the oblique parietal suture are primarily the same formations, it still remains for us to explain why under these circumstances *the incomplete sagittal parietal suture suffers a deflection downward*, so that it changes either wholly or in its anterior part from a sagittal to one of an oblique direction."

Ranke's above statement embraces the theory of an identity of the posterior incomplete horizontal parietal suture with (at least) that which passes in an oblique or angular direction, between the posterior and the inferior borders of the parietal, separating its mastoid angle, or, rather, its postero-inferior portion; and the existence of conditions capable of deflecting the horizontal suture downward and making it reach the inferior parietal border. The deflection of the suture is produced, according to Ranke, "through a break (Einknickung) in the 'plastically' (after G. H. Mayer) upturned posterior border of the parietal."[1] He says: "It is my opinion that these formations occur mostly in a similar way as the

[1] "Sind schon aus früheren Entwickelungsepochen kürzere sagittal spaltungen im Scheitelbein vorhanden, so führt die Abknickung diese Spalten in der Knickhaute nach abwärts."

artificially produced sutures by Gudden,[1] and that is by the cracking (Einknickung) of the skull in consequence of the counterpressure (maintained by Mayer[2]) of the spinal column against the heavy, exceedingly pliant and breakable skull. In instances where there are no primary sagittal clefts in the parietal, which would facilitate the cracking in a definite direction, there will be split off, through the same process and parallel with the lambdoid suture, quadrilateral pieces of the parietal, those well-known so-called 'colossal intercalated bones (Schaltknochen),' which are in reality pieces of the parietal bone, and are mostly separated from the neighboring parts by well-formed and serrated sutures."

On pages 63 and 64 of his memoir, Ranke reiterates his opinion, and his final expressions on the point are as follows: "The investigations into the development of the parietal bone have brought forth no better explanation of the *oblique parietal suture* than those previously attempted. In any case, there is no ground on which we could attribute to the separated, independently appearing mastoid angle the same significance with the inferior elementary parietal, as was the desire of Gruber. Neither can I agree unconditionally with the ideas of Toldt, who also means that, without anything further, he can refer the condition, equally as the separation of an 'upper' from a 'lower half,' to the 'typical dicentric foundation' of the parietal." "I would adhere primarily to the before expressed opinion, that in cases of the 'oblique parietal suture' we have to deal with a deflection, due to some, perhaps a *mechanical*, cause, of that, even in the new-born, so frequent, posterior *incomplete* sagittal parietal suture; this suture through a mechanical breaking off of the mastoid angle not only is bent downward, but carried even to the border of the parietal." "It should, however, also not be passed over in silence that such a small separation, as shown on fig. 13, p. 303, can arouse the thought that here, perhaps, we are confronted with something that is no more than a fontanel-bone." . . .

[1] Gudden, Experimentaluntersuchungen ü. d. Schädelwachsthum, München, 1874.
[2] Mayer, G. H., Statik und Mechanic d. menschl. Knochengerüstes, Leipzig, 1873, pp. 233–236.

No opinion has thus far been formulated (unless it was by Zoja, whose publication was not accessible to me) in regard to the instances of an apparent extension of a parietal division into the temporal squama. . . .

Résumé: Causation of Parietal Divisions in Man.

The above notes illustrate that we are confronted by a number of more or less varying theories, formulated mainly on the basis of the rather scanty human material, both as to the fundamental and the determining causes of parietal divisions, particularly those of a very oblique course or extending between two connecting, instead of two opposed, borders of the parietal.

In so far as the *fundamental* cause of the "typical" sagittal divisions are concerned, there is a general agreement as to the development of these by an independent growth of, and the eventual forming of, a regular articulation by two portions of the parietal, the only points of difference among the authors relating to the exact morphological value of these two portions. As to the very oblique and the infero-posterior divisions we have several radically distinct tendencies of opinion. There is a series of authors who are inclined to consider these divisions as equivalent with the "typical" sagittal ones, or, at least, developed as a consequence of a separate center of ossification of the parietal; a smaller group, represented mainly by Coraini, who associate the additional portion of the parietal with intercalated bones; and finally one observer, Ranke, looks upon these formations as at mechanically extended normal fœtal fissures which are ordinarily found in the posterior border of the parietal bone.

As to the *determining* cause of the anomaly in its "typical" form, we have the theory of Calori and Coraini, which attributes the formation of the additional parietal bone and the subsequent parietal suture to the effects of a disproportion from physiological or pathological cause between the growth of the cranial contents and the cranial vault; and the theory of Virchow and particularly Ranke, which seeks the cause

in a premature union of other normal cranial sutures, and the consequent increased strain on the separation between the two embryonal portions of the parietal, if this separation happens to be still open; and, somewhat indirectly, the implied theory of reversion or reminiscence, of Maggi. The *determining* cause of the very oblique antero-posterior, the infero-posterior and other parietal divisions is, with those who consider these divisions as equivalent to the "typical" ones (including, notwithstanding their varying view of the whole subject, Calori and Coraini, as well as Maggi and Frassetto), evidently primarily the same as that of the "typical forms." For Ranke, as we have seen, the cause of these atypical parietal divisions is entirely different from that of the "typical" ones, and consists primarily in the counterpressure of the spinal column against the cranium, the influence inducing direct or indirect breaks in the postero-inferior part of the parietal bone, which breaks persist in the form of a suture.

The Morphological Value of the Complete Antero-Posterior Parietal Divisions in Man.

The differences of opinion as to the *morphological value* of the two portions of the sagitally divided parietal are represented by the views of Toldt, Maggi, Calori, and Ranke. Toldt held that two separate portions develop from the ordinary two foci of ossification, to which foci he attributed no special significance; and Maggi's (with Frassetto's) position, though assuming more than two centers of ossification for the parietal, is similar. For Calori, and particularly Coraini, of the two portions of a divided parietal, one represents the real, original, the other an accessory, Wormian-like bone. For Ranke the two portions represent two *ab origine* distinct and equivalent parietal bones.

Of these several views that of Calori and Coraini appears to me to be the least tenable. It is true that large "accessory" bones occur in the location of the fœtal fontanels and in all the normal parietal sutures. It is also true that in extremely rare cases the accessory bone, particularly that which

occurs in the temporo-parietal suture, may extend, with one or more interruptions (and possibly continuously), along the whole border of the parietal; I have seen two or three instances of that condition and find several such cases on record. But the "typical" sagittal parietal divisions have characters of their own which will easily differentiate them from the formations just referred to. Let us take such a case as Soemmering's, or Ranke's, or those of Turner. Both portions of the divided parietal in these cases are large, though the upper exceeds more or less the lower one; the parieto-temporal accessory bones have never been seen to attain at any point comparable dimension. The suture that separates the two portions of the divided parietal is usually well serrated, though it may at the same time be slightly to moderately squamous; the suture that separates the accessory temporo-parietal bone from the parietal is only and eminently squamous. The accessory formations are, with the rarest exceptions, very irregularly subdivided, but there is no instance where either portion of a sagittally divided parietal has shown the slightest indication of a subdivision. Calori and Coraini suggest that the large accessory bone may have been produced from but one accessory center, which brings their theory very much nearer that of Toldt and his followers; but how can we account, especially in the absence of marked signs of an excess of a physiological brain-growth, a hydrocephalus, or other abnormalities, for a development of the necessarily secondary and later "accessory" center, equalling, or almost equalling, the original center of ossification of the parietal? It seems to me that on the basis of these considerations alone, and without reference to the embryological data now in our possession, or to the normal partial parietal divisions in the new-born in a situation corresponding to that of the anomalous, complete, "typical" division, the accessory-center theory of the origin of the "typical" sagittal parietal divisions must be abandoned.

Toldt's, Maggi's, and Ranke's views differ essentially in the attributed morphological value to the two centers from which the "typically" divided, as well as the ordinary, parietal

develops. For Toldt and Maggi the centers have apparently no different meaning from that of similar centers of other cranial and skeletal bones; for Ranke, it does not appear on what basis, they represent two distinct parietals. Should Ranke's view be correct, and as we do not meet with double parietals as a regular feature in lower mammal life, we should be in the presence of either an early stage of a highly interesting neomorphism or appearance of a new cranial bone, or a very far-reaching reversion, such as implied by Maggi. The presence of a double parietal would then either denote a sign of organic precociousness, and individually rather a progressive character, a superiority; or a very inferior animal feature. There would be little need, then, of searching for a cause of the "typically" divided parietal in the pathological premature synostosis of some of the normal cranial sutures. Also, there is no barrier which would restrict the idea of an equivalence of the centers of ossification with distinct bones, to the centers of the parietal; it would have to be extended to the centers of other bones, the occipital, the malar, the superior maxilla, the scapula, pelvic bones, femur, etc., which would give an entirely different aspect from that which we now have of our osteology, and for this we are as yet hardly prepared. However, Ranke's theory cannot be lightly disposed of. It seems to disturb our current notions about bones; but it only seems so, for upon reflection it must be acknowledged that we have no clear and generally established notions relating to the morphological value of the centers from which our bones develop. What proofs, or even indications, are there that our adult bones are *primary* morphological units and not composites of different, at some period in the individual or even terrestrial life, independent parts? There are not only no such proofs, but there is much that favors the assumption that our adult bones are such composites, that they are really phylogenetic and ontogenetic resultants from a varying number of more or less independent bone units. We do not consider a normally synostosed cranium or a part of the spinal column or any other portion of the skeleton a single bone, yet the relation between an adult bone and its early constituents, and

the synostosed cranium and its early constituents, is more an apparent than a real one. It is decidedly attractive and seems possible to look at the early steady constituents of all the adult skeletal parts as at separate formations, separate units of the organism. They do not, however, it seems to me, represent distinct "parietals," or "malars," or "maxillæ," or "scapulæ," etc.; these terms belong only to the composites, to the synostosed aggregates, of the earlier, elementary portions. In the case of the "typical" division of the parietal it is not *two parietals* that we have, so much as *two parts of the parietal*, or, at most, *two persisting elementary parietals*. Properly, we should not speak of these cases as *divisions*, but rather as of *anostoses* of the parietal; and, similarly, of anostoses instead of divisions of the malar, etc.

The Morphological Value of the Very Oblique Divisions and those that Run between two Connecting Borders of the Parietal in Man.

Due to their location and extent, the *very oblique* antero-posterior and the *infero-posterior* parietal sutures have been separated into a special group, and are considered, principally by Ranke, as being of a different signification from the "typical" sagittal sutures of the parietal bone. Such a separation is, so far as the very oblique antero-posterior sutures are concerned, entirely artificial. There is no such a thing as a "typical" sagittal suture. In all the instances of a bipartite parietal the suture was more or less oblique, never perfectly horizontal, that is, terminating at exactly the same distances from the pterion and asterion as from the bregma and lambda; and there were observed, without any great interruption, all the degrees of obliquity. There are cases on record, speaking still exclusively of man, where the suture nearly halves the parietal antero-posteriorly, as in Soemmering's specimen and others, particularly two of the fœtal skulls of Hyrtl, where the division runs very nearly from one angle of the parietal to an opposite angle. In such circumstances on what basis can we separate morphologically any special

number of the antero-posterior sutures from the others? Toldt's and Ranke's embryological investigations both show that the elementary parts of the parietal are seldom, if ever, situated perfectly one above the other; and if not so at that early stage of life, why should we wonder at finding them in a similar, perhaps more or less accentuated, position later? The accentuation of the obliquity of the space, later on, suture, between the two parts, is easily explainable by differences in growth of the two, differences which we know to exist, for probably the parts are never, when full grown, of the same dimensions. There seems to me to be no possibility, unless some further evidence of their difference is adduced, of separating the more from the less oblique antero-posterior sutures of the parietal, and I cannot but second the opinion of Toldt and others, that the more oblique antero-posterior parietal sutures are morphologically identical with the less oblique ones that cross the bone in the same direction. They both form the boundaries between the variously developed, persisting elementary parts of the parietal.

There is a greater difficulty in determining the proper significance of those portions of bone which occasionally represent in a separate state more or less of the postero-inferior portion of the parietal. The sutures separating these differ in nothing, except in a greater tendency to angularity, from the antero-posterior parietal sutures. In location they range from those that run from the middle of the posterior to, or even anterior to, the middle of the inferior border of the parietal, to those that are unmistakably the boundaries of Wormian or fontanel bones. Their posterior termination, as Ranke remarks, is mostly at about the same point as that of the antero-posterior sutures. The bones which these postero-inferior sutures represent have distinctly the appearance of parts of the parietal. They never encroach in any marked degree, as Wormian or fontanel bones are apt to do, on the neighboring bones, nor have they been seen to be in any way subdivided, or to extend into the temporo-occipital suture, or appear extended by Wormians along and at the expense of the posterior or inferior parietal border.

There are, as mentioned, in the main, three theories about these "separations" of the postero-inferior portions of the parietal. Of these the theory of Ranke, attributing them to a mechanical separation extending in the course of the partial posterior parietal suture, appears to be the least tenable. In the majority of instances of the anomaly there is no evidence of any turning up of the posterior border of the parietal, nor any other abnormality which would point to any special effects of the counterpressure of the spinal column. The first effect of such a counterpressure in a case of an abnormally yielding skull is exerted on the base of the skull, and results in a depression of the region about the foramen magnum. Should the effects of the counterpressure of the spinal column lead to a cracking of the parietal, it is reasonable to suppose that a similar effect would be even more observable on the more directly affected occipital bone, which is also provided at birth, and considerably after birth, with incomplete sutures; but thus far there is no evidence of any such cracking on the occipital. I have examined more than a dozen skulls with a more or less pronounced basal depression, and quite a large number of crania with various, in some instances very pronounced, degrees of turning up or bulging of the posterior, or anterior, or both posterior and anterior parietal borders, without finding any cracks or a separation of mastoid or other angle. Besides this, it is well known that in cracks or fractures of the parietal there is generally a tendency, even in adults, to repair and not to a persistence of the separation; and, if it occurs in addition, why should the cracking in the posterior part of the parietal lead always downward, and never very irregularly, as is common with fractures, or forward or upward?

There is another consideration to which I have referred in a previous publication (37, p. 289 *et seq.*), namely, how can a turning up or bulging of the posterior border of the parietal affect, without apparently displacing its posterior termination, the anterior end of the incomplete parietal suture? This suture, which is dealt with more in detail in another chapter, is the remnant of the space that exists normally in fœtal life

between the distal portions of the growing and centrally united segments of the parietal. This being its origin, its course must always lie in the line of the union of the segments, and this line points generally towards the parietal eminence. By the time the posterior parietal border comes in contact with the occipital, the posterior incomplete parietal suture is bounded both superiorly and inferiorly by firm bone substance, under which circumstance it is quite impossible to imagine any disturbance, mechanical or pathological, that could affect mainly or solely the more central portion of the suture, and deflect as well as extend it downward to the inferior border of the parietal. There are, to quote partly from my previous paper on this subject, only two factors that could possibly affect and modify the course of the incomplete posterior parietal suture, and both of these would show their influence mainly or entirely on the distal portion of the same. These two factors are, first, an abnormal development, either defective or excessive, of the posterior part of one of the original parietal segments; and, secondly, influences that would interfere with the freedom of full growth of the posterior border of the parietal. In the instances of the first order, as can easily be imagined or even artificially demonstrated, there would be possibly only a lower or higher situation or an obliquity affecting mostly the marginal portion of the division. The results would be oblique or curved sutures diverging from the parietal eminence,— effects entirely different from the actually observed oblique sutures that sever the lower portion of the parietal, or its mastoid angle.

Influences interfering with the free development of the posterior border of the parietal bone could only deflect upward or downward the marginal end of an incomplete parietal suture; only in cases of a very short suture could they possibly render it oblique or curved in its entirety. But even in these cases it would be the peripheral termination of the suture that would be mainly affected. Of this, however, the known instances of postero-inferior parietal sutures, in man or other mammals, afford no illustration.

A theory which meets with so many practical difficulties

as the theory of Ranke under consideration, should not be accepted before it can be supported by more convincing arguments and practical demonstrations.

The above considerations do not, of course, deny the possibility of an ordinary parietal fracture from the usual causes of such an accident, and the possibility of this fracture appearing similar to, or even indistinguishable from, a postero-inferior parietal suture. Actually I was not able to find any record or any example of such a fracture; but that does not make it an impossibility. I have seen several skulls where the ordinary, more or less irregularly sagittal or vertical parietal fracture simulated very closely an anomalous parietal suture. Gruber (22) describes one case as an instance of an oblique parietal suture, while Hyrtl and Ranke both consider that case as one with an acquired division. To differentiate a congenital real oblique suture from a division which is the result of a fracture, we must be guided largely by the situation, form, and serration of the division, and the condition of the surrounding bones, especially that of the opposite parietal. A straight course, ending with one extremity in or near the middle of the anterior or posterior border of the parietal, a complex serration, no continuity of the division on the neighboring bones or multiplicity, and particularly a co-existence of an allied or similar division on the opposite parietal,—all favor the conclusion that the division under consideration is a real congenital suture, and not the result of a fracture.

As to the theory of a morphological equivalence or identity of the minor portions of the parietal separated by an infero-posterior with the inferior ones separated by an antero-posterior suture, there are reasons to believe that in at least some instances this view is a correct one. Without adducing in this place the evidence of other material than that in man, we have one fact of considerable value in support of this opinion. This fact is the almost general and sometimes (cases of Gruber, Putnam) very marked preponderance anteriorly of the superior over the inferior part of the bipartite parietal. In view of this fact it beomes very probable that at times the relative position and growth of the elementary parietals may

be such as to condition an inferior instead of an anterior termination of the parietal suture. We shall return to this point later, when considering the evidence afforded by the material on monkeys.

The accessory- or Wormian-bone theory of Calori and Coraini, to which also Graf Spee inclines, would be more defensible if we still held to the old view of the one-center development of the parietal. Yet, even with our present knowledge, the compensatory-bone theory cannot be entirely refuted, and may be right in some instances. The formation of accessory bones arising from accessory foci of ossification in places of defects of the normal bones is the rule, and occasionally such bones reach dimensions which fully equal those that appear to be the separated postero-inferior part of the parietal. The mastoid angle of the parietal develops somewhat later than the other angles of the bone, which rather favors the development of accessory bones in the posterior lateral fontanelles. Due to these facts, in some instances, such as one of Ranke's cases (36, fig. 13) or the Peruvian in my former paper (37, fig. 6), a diagnosis between a part of a parietal, developed from an original center, and a Wormian or fontanel bone, developed from an accessory and relatively late focus of ossification, is, I believe, impossible. But we can not extend the accessory-bone explanation to all the independent pieces of bone that form postero-inferiorly a portion of the parietal. I have adduced some of the reasons for this before, but they may be repeated. In the first place, as even Ranke acknowledged, the majority of the postero-inferior sutures have something characteristic, in that they terminate posteriorly in nearly the same location, which corresponds to the location of the normal incomplete posterior parietal suture, or the remnant of the original space between the two elementary parts of the parietal. In the second place, there were not observed in the recorded cases of the postero-inferior parietal suture signs of an inordinate cranial distention or other marked defects in the ossification of the normal cranial bones, which, though perhaps not constant, are certainly more frequent in crania with the more marked Wormian formations.

The real postero-inferior fontanel bones are usually irregular in form; all intercalated bones tend to encroach on all the surrounding parts; and there is a pronounced tendency to multiplicity in the intercalated bones — all of which is different with the portions separated by the postero-inferior parietal suture.

As to the suggestion of Coraini that in these cases the accessory bone ossifies from one accessory centre and represents an advanced phase of a Wormian formation, it may be remarked that the single Wormian bones are passive results of conditions in individuals, and can have no definite history of their own, no regularity, no phases of evolution. Should ever a Wormian bone show a tendency to a regularity and differentiation it would be on the road to become a new cranial member, equivalent with the normal cranial bones, and cease to be a Wormian.

Coraini's reference to the possibility of an occasional development of the parietal from three centers is, leaving the "accessory" denomination of two of the centers aside, well worth consideration. There is but one, and that not very satisfactory, case in man (Fusari's) of a tripartite parietal; but there are several cases on record of a distinctly angular postero-inferior parietal suture which could be most satisfactorily explained on the basis of a tricentric, not, however, necessarily Maggi's, theory. This point, also, will be more advantageously treated later.

The Determining Causes of Parietal Divisions in Man.

The subject of the *determining* causes of the bipartite parietals has been partly touched upon. The objections were stated in regard to Ranke's theory of breaks, due to the counterpressure of the spinal column upon the cranium, as causes of the very oblique antero-posterior and the infero-posterior parietal sutures. Calori's and Coraini's theory of a disproportion of growth between the cranial bones and the cranial contents, with the consequent detraction of nutrition from the original one, and an appearance of an accessory center, must fall, as it is mainly with the old one-center view of the

development of the parietal. The theory can, however, be slightly modified and made to apply to the di-centric or tri-centric parietal. The question arises, could such a disproportion of growth between the cranial contents and vault, due either to physiological or pathological causes, prevent the union of the elementary parts of the parietal? Such disproportions of growth, particularly those due to pathological causes, above all hydrocephalus, do occur; but do they ever occur early enough to prevent the normal very early union of the parietal portions? This question can be properly answered only by further research in embryology. Should in any instance the normal union of the parietal portions be delayed until those periods in the fœtal life in which we know hydrocephalus to occur, it is very probable that the condition would further delay, from the very causes mentioned by Calori (mechanical and effect on nutrition of the bones), the union of the parts, or even induce their persistent separation. That a hydrocephalus or any other condition could ever separate centers that have already more or less coalesced seems highly improbable.

Virchow's and Ranke's theory attributes the determining cause of the "typical" sagittal parietal sutures to a premature union of some of the normal cranial sutures. This hypothesis evidently comprises two distinct elements, acting more or less conjointly or even interdependently, namely, a retardation in the normal closure of fœtal divisions of bones and a very premature synostosis of sutures which normally persist well into life. Applied to the parietal bone it presumes, to start with, besides the existence of a complete separation of the two foci of ossification, also a separation of the two portions of the parietal bone developing from those foci up to the time of the formation of the parietal articulations. When the parietal centers fuse normally, the event occurs much earlier than the meeting of the parietal with other bones and the formation of cranial articulations, hence much earlier than before synostosis is possible. If a union of the elementary parts of the parietal is present from another cause until the occurrence of a premature synostosis of some cranial articulation, this latter event will undoubtedly favor the persistence

of the parietal suture. The cause is of approximately equal value with that of hydrocephalus. It does not reach the primary cause of the parietal suture: the retardation of the parietal union.

Both Coraini and Ranke suggest, though the latter only indirectly, that the bipartite parietal represents a neomorphism. Should this view be correct, the retardation of the union of the elementary parts of the parietal would be attributable to the trophic nervous centers, under whose direction or influence all growth proceeds. The objection against neomorphism is the extreme rarity of the anomaly in man. The phenomenon might be imagined as neomorphism in a stage of otherwise overcome need or a stage of failure, and then really a sort of atavism, — but with the material on man alone this would be mere conjecture.

Maggi's view of the homology of the divided parietal with certain conditions in the Stegocephali, Batrachians, etc., needs, to say the least, very much further study and demonstration.

Critical Remarks Concerning Parietal Divisions in Apes, Monkeys, and other Mammals.

After the above considerations, which were made solely in reference to man and on the basis of previously known material, it remains for us to briefly point out in which way the material on apes, monkeys, and lower animals, including that here published, influences the discussed theories concerning the various parietal sutures.

Perhaps the most striking phenomenon of those that may now be considered as fairly established, is the absence or excessive rarity of all forms of parietal separations in the lower mammals, up to the monkeys; the sudden frequency of such divisions in monkeys, particularly in certain groups; and a probably similar frequency in the apes, or at least in the orang and chimpanzee. The frequency of the anomaly in man is considerably less than that in monkeys and apes, though greater than that in the carnivora and lower mammals.

There are no traces of any pathological conditions, such

as hydrocephalus; no traces of premature synostoses of normal sutures; and no traces of any effects of a counterpressure of the spinal column upon the skull. This shows plainly that, at least in the apes and monkeys, parietal separations are not due to any of these conditions. Parietal separations in apes and monkeys seem to be examples of disturbed normal development, or *dismorphism*, with, perhaps, a tendency towards neomorphism. The much more frequent occurrence of the separations in monkeys and apes than in man makes it possible that, after all, the anomalies in man may represent more or less a sort of atavism.

Parietal sutures in the apes and monkeys show a greater variety in location than those in man. Among this variety there is a very marked preponderance of vertical, and a relative scarcity of sagittal, sutures in the monkeys; in the apes, and particularly in man, it is the sagittal sutures that preponderate. This phenomenon can only be explained by an assumption of a difference in the relative location in monkeys and apes with man of the centers of ossification of the parietal. In monkeys these centers are apparently mostly anterior and posterior, in the apes and man almost as a rule more or less inferior and superior, or, rather, ranging from an antero-superior and postero-inferior to almost perfectly superior and inferior. There has been manifested somewhere between monkeys and apes a tendency towards a reaccommodation of the not very steady position of the centers, directed, in all probability, towards an arrangement more suitable to the needs of the higher organism. With the various cases in monkeys and apes at hand, it is easy to understand the oblique parietal sutures and even the more or less vertical ones, as those of Fusari and Coraini. The vertical parietal sutures in man represent apparently a greater degree of atavism than others.

In several of the monkeys and particularly in the chimpanzee, we have a practical demonstration of the mode of formation of those parietal sutures that run between two continuous borders. In the chimpanzee the suture is equivalent to the antero-posterior one of the other parietal; in this case both

the parietals developed from two elementary parts. In some of the monkeys (cases 47 and 48), on the other hand, it is clear that the parietal developed from three centers. Case 47 is particularly instructive, showing the formation, by an early synostosis between the anterior and the postero-superior parts, of the "separation of the mastoid angle." Barring the "accessory" nature of any of the parts, this case is a beautiful illustration of Coraini's hypothesis relating to the angular postero-inferior parietal sutures and a proof of the validity in at least some cases of Maggi's three-center theory.

The theory of an identity of the minor parietal separations with Wormian bones finds no support and much contradiction when our observations are extended to apes and monkeys, in which formation of even very small intercalated bones is quite a rarity.

A number of very interesting observations which require a special notice is presented by the parietal separations with an apparent extension into the temporal or frontal squama. Only two such cases have been thus far mentioned in literature. One of these, of which I have no particulars, not having been able to obtain the publication, was described by Zoja (52), while the other has been mentioned in the following words by Graf Spee (51, p. 115): "There is in the local (Kiel) anatomical collection a skull in which the temporal squama is divided into an upper and a lower half by a sagittal suture. This division proceeds backward into the parietal bone, in the direction of the summit of the occipital bone, without, however, reaching the lambdoid suture. The pieces of the upper part of the temporal squama and lower part of the parietal bone, separated by this extremely rare suture, are perhaps referable to intercalated bones (Schaltknochen)."

Graf Spee's explanation of the anomaly is not applicable to the cases that came under my observation, where the apparent prolongation of the parietal suture or fissure was mostly incomplete, and often directed in such a way that there was no possibility of its having been a part of the boundary of any intercalated bone. In these cases we have to search for another explanation.

It is not impossible that in extremely rare cases two independent sutures or fissures, each in a different bone, may terminate opposite each other in such a manner as to appear like one division; or that both divisions are the unrecognized results of fracture. However, the more ordinary and perhaps almost regular origin of these separations which seem to continue in the adjacent bone, is, I believe, as follows:

It is a well-known law (Virchow) that all persisting sutures or fissures in a bone, such as the parietal, favor a greater growth of so much of the bone as is affected by the separation, than takes place in the parts not so affected, and the augmentation takes place principally at right angles to the separation. Granted that we have a more or less vertical division of some sort in the inferior portion of the parietal, this portion will increase in length. If in a rare instance this increase shall be hindered by a firm articulation with the temporal squama, there will be developed a state of tension acting on the squama, and under such conditions a jar or a blow, or possibly even the strength of the tension itself, may cause a fissuring of the squama. Other bones than the temporal are not so often affected by such a fissuring because of their greater strength and resistance.

This theory is able to account for all the instances of a parietal suture or fissure with an extension that I have come across, and may account for others. Why the anomaly is not present in all cases in which a parietal division terminates in the inferior border of the bone, can only be explained by the suppositions that in such cases either the border of the squama is very resistant, or it is not firmly articulated with that of the parietal, or, finally, it grows at a like rate with the parietal border.

A notable fact about the anomalous parietal sutures is their preponderance in the male sex in man, while no such difference is marked in monkeys. The phenomenon is not easy to explain or even to form a plausible theory in relation to. It nevertheless seems to indicate that some one or more of the characters by which, regularly or perhaps but occasionally, the

male skull differs from the female, act in their earliest or fœtal stages as direct or indirect causes of the parietal division. The occurrence of the anomaly in the female would then be explainable by the presence in the particular skull of those same masculine characters to which the just-made reference may be applicable. What these characters may be is thus far purely a matter of speculation. They could, perhaps, be detected if all the known specimens of complete parietal sutures could be brought together and be carefully re-examined and measured, and compared with average normal male and female crania of the same nationalities to which belonged the skulls with the anomaly.

A few words in conclusion about the relation of the parietal sutures with the temporal ridges. The relation between the complete sagittal sutures and the superior line of the ridge, which Hyrtl hinted at, is now well known to be but accidental (*v.* Ranke), and it is clear that neither part of the ridge can stand in any etiological or morphological relation with the vertical or very oblique parietal sutures. It is true that the anterior extremity of the complete or incomplete sagittal parietal suture in man terminates not infrequently near or in that portion of the ridge that crosses the coronal suture, but this seems to be mainly, if not entirely, due to the fact that normally and independently both the ridge and suture reach the anterior border of the parietal near the same point.

General Conclusions.

All the data thus far adduced make possible the following main conclusions:

(1) Complete separations in the parietal bone are nearly, if not entirely, restricted to monkeys, apes, and man.

(2) The separations are much less frequent in man than in apes and monkeys. They also are not equally frequent in all the subdivisions of apes and monkeys, and possibly in the different races of man, but in the latter this point is still uncertain. In man there is a preponderance of parietal

sutures in the males, but in the monkeys the sex seems to have but little influence on the frequency of the anomalies.

(3) The parietal sutures are divisible into two main groups, namely, into those that run between two opposed, and those that run between two connected, borders of the parietal. The former group comprises all the complete antero-posterior and infero-superior, the latter group, all the other oblique or angular sutures.

(4) There is a marked preponderance of infero-superior and scarcity of antero-posterior sutures in monkeys, while the reverse is the case in apes and man. Of the minor complete divisions the ones almost exclusively met with in man are the postero-inferior ones; in monkeys and apes we meet with these and also with postero-superior, antero-superior, and antero-inferior sutures.

(5) The possibility of the major parietal separations is explainable by a persistence of the original separation between two regular and ordinarily early coalescing centers or elementary parts, with which we became acquainted mainly through the researches of Toldt and Ranke. The presence of a congenital major division of the parietal of an ape, monkey, or other mammal is only explainable on a similar basis. Judging from certain cases, particularly in monkeys, the development of the parietal may take place from more than two centers; how frequently this is the case remains to be determined by further embryological investigations.

(6) The difference in location of the major parietal sutures in man with apes and monkeys points to a different original location of the parietal centers. There is also probable, in view of the variety of parietal separations, a lesser fixity of the centers, both in location and number, in the monkeys than in man.

(7) A preponderance of growth in one of the elementary parts is accountable for the smaller differences in the location and direction of the major sutures, and the same condition, if excessive, may produce a suture that runs between two continuous borders of the parietal.

(8) The majority of the parts of bone that are separated

from the body of the parietal by a suture, particularly an angular suture, that runs between continuous borders, are developed from one of the original parietal centers.

(9) The occasional smaller bones that bear the aspect of parietal separation cannot be distinguished from the purely compensatory (Wormian or fontanel) bones, developed from accessory foci of ossification.

(10) The determining causes of the various parietal separations are divisible into primary and contributive. The primary cause of the anomalies in the monkeys is probably *dismorphism*, a disturbance of development originating in the trophic centers, perhaps more or less allied to neomorphism; in man the cause is probably what may be termed a reminiscence, or a mild form of atavism. A reversion reaching much farther back in the organic life can not be accepted without much satisfactory demonstration. The contributive causes of the parietal divisions, which can become effective only after the influence of the primary ones has been manifested to a certain degree, are all those conditions which more considerably augment the intracranial pressure, such as, in man, hydrocephalus and very premature closure of some of the normal cranial sutures.

(11) The apparent extensions of parietal sutures, complete or incomplete, are almost restricted to the temporal squama, and are, at least in the majority of instances, acquired products, due principally to the tension produced by the augmented growth of the portion of the parietal affected by the separation.

(12) Neither part of the temporal ridge stands in any causative or morphological relation with any kind of parietal sutures; but the ridges affect the synostosis and more or less the course of the sutures, if these extend into or across the ridges or into their close neighborhood.

A number of points not touched upon here will be explained in the following chapters.

VIII A. Partial Divisions of the Parietal Due to the Manner of Ossification of the Bone.

The conditions which will be discussed under this head cannot be considered as abnormal, unless they persist beyond the age at which they regularly disappear.

The parietal bone in man, monkeys, and probably also in other mammals, develops usually, as was shown in another division of this paper, from two, and occasionally from more than two, centers of ossification, or elementary parts. These parts grow rapidly in all directions until their convex borders meet at some point, soon after which in normal cases they begin to fuse at this point of contact. As the two parts grow, which they apparently still do quite independently, though in the process of fusing, their median borders gradually extend their apposition and synostosis in the direction from the original point of contact, which usually corresponds to the eminence of the parietal, towards the periphery. Between the portions in contact and the periphery there is always in man in the fœtal life, and occasionally beyond this, anteriorly and especially posteriorly (where the growth of the parts seems to be slower) a more or less wide wedge-shaped membranous space; or, in later stages, a fissure or suture-like separation. In the full term fœtus the anterior separation has in most cases already disappeared; the posterior cleft, fissure, or suture, which still mostly persists, is situated generally not far from the middle of the posterior border of the parietal and points in the direction of the parietal eminence.

These separations and clefts, or "false fontanelles," were known to Gerdy, Velpeau, Hyrtl (50), and probably other earlier observers; their origin was explained by Toldt (49, p. 85), Maggi (61, 62) and Ranke (36, p. 59). Ranke, who examined a large number of skulls of human fœtuses and children as well as a considerable number of skulls of apes for these features, has shown the interesting facts that separations of this nature may extend for a considerable distance into the parietal; and that, while in man the separations are very much more frequently posterior than anterior, the con-

ditions are the reverse in the orang, and the anterior clefts and sutures are much the more frequent. The material used by Ranke consisted of 162 skulls of human fœtuses and infants, ranging from the eighth to the tenth month in age, and 245 skulls of mostly young orangs, 8 skulls of young gorillas, 11 of young chimpanzees, and 70 of *Hylobates concolor* of various ages. The remnants and traces of the "parietal suture" were distributed among these as follows (36, pp. 59 *et seq.*, 40 *et seq.*):

"INCOMPLETE SAGITTAL PARIETAL SUTURE."

	"Remnants."				"Traces."			
	Anteriorly.		Posteriorly.		Anteriorly.		Posteriorly.	
162 young human skulls.......	5 (in 3.08 %)		13 (in 8.02 %)		1 (in 0.62 %)		27 (in 16.78%)	
245 skulls of orangs.	13 (" 5.3 %)		0	—	0	—	0	—
8 skulls of young gorillas......	1 (" 12.5 %)		0	—	0	—	0	—
11 skulls of young chimpanzees.	1[1] (in 9.1 %)		0	—	0	—	0	—
70 skulls of *Hylobates concolor*	0	—	0	—	0	—	0	—

[1] On both sides.

Besides these, Ranke found the incomplete suture anteriorly on both sides in a *Cynocephalus ursinus* and on one side in a *Mycetes seniculus* (cases mentioned before).

My own investigations on this incomplete, normal separation in the parietal bone have resulted as follows: Among 21 well-preserved skulls of new-born to 10-months-old children, I found it posteriorly in 13 cases (62 %) on both sides, in 3 (14 %) on the left side, and in 2 (10 %) on the right side. In two additional cases (skulls of a 3-months and 10-months child) there were in about the location of the division marked indentations; in one case only (skull of a new-born child) there was no trace of it to be seen. In 7 skulls (14 instances) the division was marked, corresponding probably to what Ranke calls a "remnant of the parietal suture." Anteriorly, I found in seven of the skulls, or one third of the number examined, five times unilateral and twice bilateral, smaller fissures, located between the sphenoidal angle and the middle

of the anterior border of the parietal. It was not possible to determine whether all these anterior fissures represented portions of the anterior incomplete separation between the portions of the bone developed from its centers, or were fissures of other nature.

Traces of the posterior incomplete parietal suture can be met with in many crania of children of all ages, and occasionally even in skulls of adolescents and adults. I come frequently across them in the crania of Indians. In children above one year of age and older subjects we are liable to find, as already signalled by Maggi and Ranke, the posterior as well as the anterior cleft filled by an intercalated bone; we will return to these bones in the succeeding chapter.

There are a few points of additional interest concerning the incomplete parietal sutures which appear to have not been mentioned by any author. The two portions of the parietal squama between which the crevice exists do not unite, when coming into apposition, in the manner in which the edges of the other clefts and fissures of the parietal border (*v.* below) unite. There is formed at first between the two parts a squamous articulation, in which the lower part always overlaps the upper. The obliteration of the fissure proceeds from its summit, the two portions of the shell uniting by means of fine bony spiculæ, which all have a backward and upward direction, starting from the border of the lower portion. This border shows occasionally a slight serration.

In all my cases without an exception the incomplete parietal suture was directed towards the parietal eminence.

In a number of instances the suture was traceable further ventrally than dorsally.

The posterior suture is present, though I do not know with what frequency, in new-born negroes and, as I mentioned before, it is not rare in the Indians. I have also seen it in monkeys (*v.* Part IV), and in seven very young coyotes, but in no other mammals.

When an incomplete parietal suture, which is a normal feature of the fœtal and even the young infant parietal bone, persists into advanced childhood or even into adult life, as

in the three Bavarian skulls Ranke mentions, it assumes the significance of an anomaly and a relation to the persistent complete parietal separation.

But, incomplete parietal sutures are not the only divisions which may be normally observed in the borders of the parietal during its development. The two elementary parts of the parietal ossify in rays, which radiate in all directions. These rays, I have been convinced by numerous examinations, advance in the osteogenetic membrane not indiscriminately, but, possibly under well-established influences of the nervous system and the blood supply, in a definite and quite constant manner. They constitute several tufts, separated by more or less marked clefts or fissures. The periphery of each tuft is composed of many individual rays of bone, and these rays also are separated on the periphery by clefts or fissures. These separations between the tufts of the bone seem to me to be of some morphological significance and they may be conveniently termed the *primary parietal fissures* (reserving for the intercentral separations the term suture). The numerous minor clefts between the individual rays, which are of but a very little if any importance, may be distinguished as the *secondary parietal fissures.*

The form of the primary fissures in a new-born child is mostly that of a narrow V, but it may be that of a line. Not rarely the border of the parietal will show about the mouth of the fissure more or less deficiency, the result of which is a small, triangular or irregular membranous space, a sort of a supernumerary fontanel.

Any of the primary fissures may be fully synostosed at birth, though this occurs more frequently a little later and sooner with some than with others. The fissures that are still present at birth ranged in length in the skulls I examined from a few millimeters to two centimeters.

As to the exact number of the primary fissures I am not fully certain; this point has to be settled by further investigations on bones of fœtuses obtained at various periods before birth. There are four situations in which the fissures occur almost constantly.

The first and only well known of the slits is situated at about the junction of the middle with the posterior third of the sagittal border of the parietal bone. This point, which corresponds to *obelion* (Broca), is about 2.5 cm. above the lambda in the new-born child (Hamy), or about 7 cm. above the lambda in the adult (Broca). In the adult the location of the obelion is generally marked by a moderate flattening or depression of the parietal borders, by a marked simplification of the sagittal suture, and by one or two vascular openings, the parietal foramina. In the new-born child there occurs at this point either a marked triangular fissure, or a deficiency in the border of the bone, or, most frequently, both, fissure and deficiency. The formation has been studied clinically particularly by Gerdy (44), Barkow (39), Welcker (17), Hamy (45), Broca (38), and Augier (46), and more recently especially by Maggi (61, 62).

When the just-mentioned primary incisure is narrow and not accompanied by a marked deficiency of the sagittal border of the parietal bone, Broca terms it the *parietal incisure*. When the slit is wide at its mouth or accompanied by a deficiency in the border of the bone, it forms, alone or with its fellow of the opposite side, a membranous space, the *parietal fontanel*, or, as it has been termed by Hamy, the *fontanel of Gerdy*. This fontanel occurs, according to Broca (with whose examinations my own agree), about once in every four cases of new-born children. Broca properly attributes to both, the incisure and the fontanel, the same signification and the same etiology; they are, however, both represented as being due to 'a somewhat retarded development of the parietal in this situation, due to a more feeble nutrition in this than in other parts of the bone,' which theory is hardly tenable. There are cases in which such a "retarded development" may account for the deficiency in the parietal border; the fissure, however, is distinctly a normal slit of a different signification.

Maggi's and especially the still more recent Frassetto's (67, 69, 70) contributions to this subject tend to give the "parietal incisure" the valency of a partial parietal suture, while the

"fontanel of Gerdy" is likened to the parietal pore in the *Stegocephali*.

The "parietal incisure," or the fontanel, when this is present, becomes occluded in most cases within three months after birth (Broca); exceptionally, however, it may remain open longer. I have seen cases where the incisures were marked at the ninth and twelfth months after birth, and in rare cases the incisure may last even after this period. In rare instances there is found in adults in this location a suture, which runs in a more or less vertical direction over a portion of the parietal. Such a suture, instances of which have been seen by Otto, Broca, Pozzi, and Hamy (*v.* Part II), represents probably in most cases a persistence of a larger portion of the primary fissure, though it may also be a remnant of a formerly complete, *anomalous*, more or less vertical parietal suture.

The membrane which fills the fissure under consideration is in most instances traversed, at various distances from the median line or line corresponding to the later-formed sagittal suture, by a small blood-vessel. As the closure of the fissure advances, this blood-vessel is embraced by the borders of the fissure and runs henceforth in a canal, which on the skull is known as the parietal foramen. Occasionally the part of the primary fissure between this foramen and the sagittal suture remains patent, simulating, but not identical with, the *sutures to foramina* found in the parietal in many mammals (*v.* special chapter on these sutures).

In rare instances, as pointed out by Hamy, a fontanel bone develops in the "sagittal" fontanel. This bone may unite with one parietal and appear as a process of the same.

Similar slits and deficiencies as in man occur at the sagittal point in various mammals, but they seem to be generally more advanced in obliteration at birth than is the case in man. Most commonly we find in the new-born animal simply a greater or lesser depression at the sagittal point. This occurs in monkeys and in the carnivora. I saw the bilateral depression very marked in five tiger fœtuses, and somewhat less pronounced in a number of new-born lions, coyotes, and dogs. I have no observations on new-born apes. In the ungulates

the parietal bone is relatively narrower (especially in Bovidæ) than in the carnivora or primates, and, with the exception of one young camel, I could find no fissures or fontanels at a point which would correspond with the obelion.

For parietal sutures terminating at this point, *v.* Part IV.

The primary fissure next in importance occurs in the posterior border of the parietal between the incomplete parietal suture and asterion, commonly nearer or at this latter.

The only author in whom I find a mention of this fissure (though a fontanel at this point is known to Maggi and Frassetto) is Ranke, and even this observer refers to it but very briefly. In Ranke's words (36, p. 65), one of the fissures of the parietal border "can be quite frequently observed to run, in a radiating direction, from the point of the postero-inferior or mastoid angle of the parietal towards the parietal eminence." According to my investigations the fissure terminates thus mostly in the parietals of fœtuses and the new-born, but in older skulls remnants or traces of it are more generally situated slightly to moderately above the point of the mastoid angle or asterion. Its direction, as Ranke states, is towards the parietal eminence.

But there are other points of interest about this fissure. The feature is quite constant in the new-born infants and for some months afterwards; I found it, more or less well marked, and generally bilateral, in 16 (80 %) out of twenty skulls of new-born and infants less than one year old; and I have seen plain traces of it in skulls of older children. In rare instances (*v.* Part II) the fissure may persist into adult life.

The form of this slit corresponds to that of the obelion primary fissure. Like this latter it can be occasionally traced, especially ventrally, for a considerable distance towards the parietal eminence. But, while the obelion fissure seems to unite by a simple apposition, the supra-asteric fissure synostoses mostly, if not generally, in the squamous manner of the posterior incomplete parietal suture. The mouth of the postero-inferior is generally smaller than that of the obelion fissure, nevertheless it is much more frequently than the latter filled by an intercalated ossicle.

The postero-inferior or supra-asteric primary fissure seems to be rare, if not absent, in monkeys; I have never seen it in the specimens that I examined, which, however, did not comprise fœtal material. I found the fissure more or less well defined in five lion fœtuses, two young hyænas, two young red foxes, two young Virginia deer, two young sheep, one young goat, one young *Boselaphus*, two young camels, and two young pigs (*v.* detail list in Part IX, 'Divisions to Foramina').

Fig. 31. Left Parietal Bone of a new-born child, showing most of the primary fissures.

This distribution shows that, whatever may be the importance of the fissure, it is a well-established feature of the parietal.

The *sphenoidal fissures* of the parietal bone may possibly belong to the primary slits; they are generally two or three in number, and are constantly present in the skulls of new-born children. Their appearance at this stage is that of well-marked, open clefts, 0.4 to 1.0 cm. long, directed towards the parietal eminence. The clefts become obliterated soon after

birth. I found them fully obliterated on both sides in a child of three months, and on the right side in another child of about the same age. They were still present, though not very marked, on both sides in a child of about six months; but were absent in all the older specimens which I examined.

Besides the described, there are several other fissures which may possibly be primary, and which occur with some degree of frequency in the parietal bones of new-born children. One

Fig. 32. Radiations from the metopic and coronal suture in a nearly adu t *Alces americanus* (No. 13,796, A. M. N. H.).

of such marked slits occurs at bregma; two in the superior parietal border; one 1.0 to 2.0 cm. anteriorly, and the other 1.0 to 1.5 cm. posteriorly, to the obelion fissure; and one in the posterior border between the lambda and the posterior incomplete parietal suture. The slit between the obelion fissure and lambda becomes much more frequently than the obelion fissure or fontanel filled with an intercalated bone. Further observations are necessary to establish the exact nature of these clefts. (Fig. 31; Pl. XXII.)

The Left Parietal Bone of a New-born Child (ventrally), Showing the Primary Fissures (Specimen in the Collection of the Morphological Museum, Columbia University).

..DER CHILDREN.

Pre-lambdoid Fissure in Superior Border.	Exceptional.
—	—
—	—
both sides	—
—	—
—	—
both sides (Wormian)	—
—	—
both sides	A marked fissure in l. bregmatic angle.
—	
—	—
—	—
—	—
—	—
—	—
—	—
—	—
—	—
—	On both sides 1 marked vert. incisure beyond the 1st third of squamous suture.
—	
—	—
—	—
3 both sides = 14 %	
....	
14 % or abt. 1 in 7 cases	

FISSURES IN THE PARIETAL BONES OF NEW-BORN AND SLIGHTLY OLDER CHILDREN.

Spec. No.	Age.	Obelion Fissure.	"Sagittal Fontanel" (Gerdy's).	Postero-inferior Fissure.	Postero-superior Fissure.	Sphenoidal angle Fissures.	Anterior Fissure in Superior Border.	Pre-lambdoid Fissure in Superior Border.	Exceptional.
1	New-born	—	—	both sides	both sides	both sides	—	—	—
2	"	right	—	—	—	both sides	—	—	—
3	"	both sides	—	both sides	—	both sides	—	both sides	—
4	"	—	both sides	—	left	both sides	—	—	—
5	"	both sides	—	both sides, marked	?	both sides	left	—	—
6	"	left	—	both sides marked	—	both sides	—	both sides (Wormian)	—
7	"	right		both sides	left	both sides	both sides, small	—	—
8	"	—	both sides	both sides, marked	—	both sides	—	both sides	A marked fissure in l. bregmatic angle.
9	"	—	both sides	both sides, marked	both sides	both sides	right	—	
10	"	right	—	both sides	—	both sides	?	—	—
11	"	both sides	—	both sides	both sides	both sides	—	—	—
12	"	left	—	both sides, marked	—	both sides	right	—	—
13	"	both sides	—	both sides, marked	?	both sides, marked	both sides	—	—
14	New-born, or a little later	—	both sides	—	right	both sides	—	—	—
15	1st or 2d mo.	left	right	both sides	—	both sides	—	—	—
16	abt. 3 mos.	—	—	—	—	—	—	—	—
17	abt. 3 mos.	both sides	—	both sides	—	left	—	—	—
18	abt. 6 mos.	—	—	?	—	both sides	—	—	On both sides 1 marked vert. incisure beyond the 1st third of squamous suture.
19	abt. 9 mos.	both sides	—	both sides	both sides	—	—	—	
20	abt. 10 mos.	both sides	—	both sides, marked	—	—	—	—	—
21	abt. 10 mos.	both sides	—	both sides	—	—	—	—	—
(21)	13 at birth, 8 birth to one year	8 both sides = 38 % 3 left side = 14 % 3 right side = 14 %	4 both sides = 19 % 1 right = 5 %	16 both sides = 80 % (in 7 pronounced);	4 both sides = 19 % 2 left side = 10 % 1 right side = 5 %	16 both sides = 76 % (in one especially pronounced); 1 left side = 5 %	2 both sides = 10 % 2 right side = 10 % 1 left side = 5 %	3 both sides = 14 %	
		Total per cent. of occurrence 66.7 % = $\frac{2}{3}$ of the cases.	Absent in all the cases above 2 mos. 24 % = abt $\frac{1}{4}$ of the cases.	80 % = $\frac{4}{5}$ of the cases.	33.3 % or $\frac{1}{3}$ of the cases.	Present in all new-born and up to first or second month. 81 % = $\frac{4}{5}$; Absent after 9th month.	24 % = abt. $\frac{1}{4}$	14 % or abt. 1 in 7 cases	

The following list shows with what frequency and in what combinations I found the various slits in my series of 21 skulls of new-born and young infants.[1]

If we can judge from some of the persistent partial parietal divisions, some, if not all, of the last described slits occur also in the monkeys. In lower mammals relatively pronounced fissures are not infrequently seen in the very young in or near the angles of the parietal. Thus a fissure in or near the supero-anterior or bregmatic angle of the parietal was found in one young fallow deer, four young Indian buffaloes, and one young *Boselaphus*. Fissures in or a short distance above the sphenoidal angle were noticed in two young hyænas, one young sheep, two young fallow deer, one young *Bos indicus*, one young *Boselaphus*, one adolescent pig, one young hippopotamus, and in some, mostly young, seals and *Zalophi*. Fissures in or just below the superior-posterior angle of the bone were observed in three arctic foxes (adults), and one young Virginia deer. The fissures in or above the postero-

Fig. 33. Posterior third of the left parietal bone of a child within the first month after birth, showing the advancing ossification in the parietal comb, and the formation of foramina or inclosures (Morphological Museum, Columbia University).

[1] Specimens in the Morphological Museum, Medical Department of the Columbia University, New York City.

inferior or mastoid angle have already been mentioned. Some of the slits seem to be characteristic of certain species of animals, but this point must be settled on large series of proper material.

The constancy or frequency of the various primary and primary-like parietal fissures in man and mammals imparts to these formations a peculiar interest. Apparently these fissures are not casual, meaningless features, or mere accidents of growth. Some of them may be due to the mechanism of growth of the parietal, but some are undoubtedly regular features of the development, the manifestations of some as yet not understood law of the development of the bone. In view of the constancy or frequency and a definite location of the fissures, the tufts of bone which condition them assume the rôle of regular constituents, of subordinate elementary portions, of the main elementary parts of the parietal.

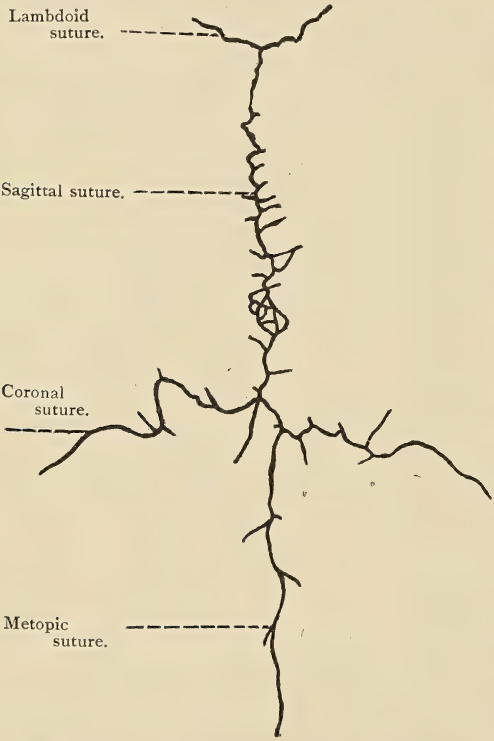

Fig. 34. Radiations from the cranial sutures in an adolescent Black Bear (No. 6639, A. M. N. H.).

The numerous *secondary parietal fissures* need only brief mention. They are present on all parts of the border of the older fœtal parietal, constituting the parietal comb. The obliteration of these crevices presents one little peculiarity. As the rays of the growing bone reach its limits, and possibly

somewhat before this, the osseous rays meet with increasing resistance to their advance. Not being able to progress freely, the ends of the rays grow laterally, thus spreading and approaching each other. A close approach between these ends is effected before the proximal part of the crevice has been filled, and a union of the ends taking place, this proximal part of the crevice is converted into a foramen (*v.* Fig. 33). The foramina thus formed in the parietal border transmit no blood-vessels and soon disappear. The cranial sutures are partly due to the interlinking of the rays and secondary fissures of the parietal and other bones.

The union of even these secondary parietal fissures may be retarded, in which case the parietal border will appear full of incisures, as in the bear and moose shown in the following figures. (Figs. 32, 34.)

VIIIB. Wormian or Fontanel Bones in the Locations of the Incomplete Parietal Sutures and the Primary Parietal Fissures.

The formation of intercalated bones in the "false fontanels" of the parietal has been known to Hyrtl, Ranke, and other observers, especially Maggi,[1] and has already been partly referred to (*v.* Part VIIIA). The bones belonging to this category are usually of moderate size and oblong, but do not differ materially from other Wormian bones, and cannot be distinguished from these except by their location. Occasionally, mainly on account of multiplicity and similar shape of the Wormians, all effort at separation of the fontanel bones must be abandoned. The recognition of the fontanel bones adds considerably to our proper understanding of the subject of intercalated bones, and diminishes very much the numbers of the purely accidental of these ossicles.

An examination of 45 complete skulls and 105 detached calvaria of whites, all with still patent cranial sutures, enabled me to find intercalated bones in the location of the incomplete parietal sutures and also in that of all the fissures

[1] (62); also Frassetto (69).

mentioned as primary, except in the antero-inferior and antero-superior angles.

The 45 complete skulls comprised 21 males, 12 females, and 5 children; there were among these 45, 14 without any Wormian; of the 31 remaining there were 17 (8 males, 8 females, 1 child) with one or more of the "fontanel" ossicles. There were, in total, 33 clearly discernible "fontanel" bones, beside which 10, in the same 17 and other skulls, were doubtful. The distribution and combinations of the 33 bones were as follows:

		left.	right.		
α	A Wormian in the mouth of the ant. incompl. par. sut.	1	4,	or in 5.56 %	of the 90 parietals.
β	" " " " " " post. " " "	5	3,	" " 8.9 %	
γ	" " " " " " post.-inf. prim. fiss.	7	6,	" " 14.4 %	
σ	" " " " " " post.-sup. " "	3	3,	" " 6.67 %	
ε	" " " " " " pre-lambdoid " "	1	1,	" " 1.1 %	

Combinations: α and β in 1
α and γ in 2
β and γ in 1
β and δ in 3
γ and ε in 1.

Fig. 35. Right Parietal Bone of a Southern Utah Cliff-dweller (child), showing remnants of anterior and a posterior parietal cleft; the posterior indentation is filled by a Wormian bone, the anterior by a spur of the frontal (No. 25, Hyde Collection, A. M. N. H.).

In the 105 calvaria, with only parts of the parietals present

α was seen clearly in 3 cases and in 4 others was doubtful; ϵ was observed in four instances and a preobelic bone in two instances. The β and γ bones could not be examined in this series; neither could a low situated α or γ have been detected.

The fontanel bones are by no means restricted to whites. They are quite frequent in the Indians, but seem to be rare in the negroes. As to other ethnic groups I have not enough proper material.

In numerous instances the mouth of the anterior or posterior incomplete parietal suture, or that of a primary fissure, is occupied by what appears to be a spur or process of the neighboring bone. In some of these instances the process is undoubtedly a partly attached Wormian. The following illustration shows a parietal in which the remnant of the anterior incomplete suture is filled by a process of the frontal, that of the posterior suture being filled by a moderate-sized Wormian. (Fig. 35.)

IX. Partial Divisions of the Parietal Bone Resulting from a Mechanical Obstruction in the Ossifying Bone; or, Divisions to Foramina.

The divisions coming under this title form distinctly a class of their own. They have a totally different etiology and signification from the sutures and fissures considered in the preceding chapters. They occur typically as fissures, or, more frequently, as nicely serrated sutures, which extend between a border of the bone and a foramen situated at some distance from the border.

Divisions of this class are very rare in the parietal bone of man and the primates, but are almost constantly present in some lower mammals. They are not restricted to the parietals, but occur in many other bones of the skull, particularly in the temporal squama and within the orbit. They are closely related to, though not identical with, the divisions which in man are so commonly observed to pass from one of the sutures within the orbit, or from the

malo-maxillary suture outside the orbit, to the infraorbital foramen.

The only location on the human parietal bone (and also on that of primates) where a suture or a fissure between a foramen and the border of the bone occurs is at the parietal point or obelion. The division, when typically present, which is very rare, connects the sagittal border of the bone and the parietal foramen. It should not be confounded with a simple incisure or suture at this point, though at times a distinction may be very difficult.

In lower mammals by far the most frequent, though by no means exclusive, location of a suture or fissure to a foramen is in the posterior half of the lower third of the parietal. (I state on the appended list the approximate location of every division found in the different animals.)

The location of divisions of this class, particularly on other bones than the parietal, is occasionally peculiar to a single species of animal and may serve as an additional sign of differentiation of the species.

In form the sutures or fissures to foramina are generally straight, or but slightly curved. The serration, when present, is fine and regular. The fissure and suture are seen to be absolutely equivalent, for in many specimens on one parietal bone we see a fissure, and on the other, in the same location, a suture.

In length the divisions under consideration range from one or two millimeters to as many centimeters. (The detail list gives the measurements of most of the divisions I found. The majority of the sutures and fissures, it will be seen, range in length from 4 to 8 mm.)

In some cases the division, although running directly towards a foramen, will not quite reach it. Apparently a part of the division, proximal to the foramen, has in these cases become obliterated. This view is substantiated by the fact that complete divisions can be found in the same locations to similar foramina in other individuals of the same species. The whole division may be found ossified; but I have never seen a case in which the distal extremity (from the foramen)

of the division would be occluded alone. Occasionally we will find a fissure or a suture in the border of a bone, without a foramen, but in a location where in other individuals of the species, or perhaps on the other side in the same individual, occur divisions from foramina. In such a case it is quite safe to conclude that the foramen, from which the division originally ran, became occluded earlier than the division.

The ossification of fissures and sutures of this class proceeds regularly from the foramen towards the border of the bone in which they occur, hence in the direction of the original ossification of the bone.

The obliteration of the sutures and fissures to foramina may occur very early, but often these divisions are patent even after some of the regular cranial sutures have united. They seem often to become occluded at about the same time that the cranial suture to which they lead is thus affected.

The number of the divisions to foramina on the same bone in the same species is not strictly limited. There may be but one, or several such divisions in one bone. As a rule there is but one suture or fissure to any one foramen; on the other hand one division may lead to more than one foramina. The frequency of the divisions stands in direct relation to the number of larger foramina present on a given bone in a given species.

The nature of the openings from which a fissure or a suture passes to the border of the bone cannot always be ascertained on a skull, but the greater majority of them seem to be vascular foramina. It is probable that a division may also proceed from a nerve foramen.

There is one more feature about the divisions under consideration which deserves a special notice. It can be frequently seen that the distal extremity of the suture or fissure, that is, the part nearest to the border of the bone, is filled with or covered by a spine, which proceeds from the adjacent bone. (In divisions in the lower portion of the parietal bone the spines proceed from the temporal squama, while in divisions of this latter the spines proceed mainly from the parietal.) The spine may simply occlude the extremity of the

fissure or suture; or it may cover a large part of the same; or, finally, it may outwardly take entirely the place of the division and reach to the foramen. The spine is usually broad and deep at its base, becoming gradually narrower and more superficial towards the extremity.

The tendency to the formation of these spines is much more marked in some species of animals than in others. When they occur in man, they usually cover a vascular canal.

The etiology of divisions that lead from foramina to the border of a bone is different from that of the anomalous divisions, as well as from that of the primary fissures of the cranial bones. The foramina from which fissures or sutures are seen to pass are very early formations, and date in all probability to the membranous condition of the bone. If we examine the growing bones in man or animals, we find the openings to present the following characters: The proximal part of the foramen—that is, that part which faces towards the center or body of the bone—is well defined, rounded, and smooth. The distal parts of the opening are more or less deficient, and this deficiency continues to the border of the bone. In very young specimens the defect in the border will be a cleft with diverging sides. On little older subjects the walls of the cleft are seen to approach. In still older specimens the walls have come into apposition, and from the now completed foramen a fissure runs to the border of the bone. Still later, the fissure gradually unites, or, the process of primitive ossification diminishing, it remains permanent. As the bone continues to grow, serration may develop in the fissure and transform it into a suture. The approach of the walls of the cleft proceeds in most cases from the foramen downward. Where the approach of the walls of the cleft had been slow, a compensatory process or spine is liable to develop from the margin of the adjacent bone, and more or less fill the existing cleft. The process or spine plays a similar rôle to that of Wormian or fontanel bones.

All the foregoing facts point to the following conclusion as to the nature of the divisions under consideration: the fis-

sures and sutures that run from foramina to the border of a bone are not characters or properties *inherent* in the bone, as were the divisions considered in Part VIIIA of this paper. They are acquired, consecutive characters, the results of mechanical obstruction, which early developed blood-vessels (or nerves) offered to the ossification of the bone. They differ from the anomalous divisions in that they are independent of the number and location of the centers from which the bone develops.

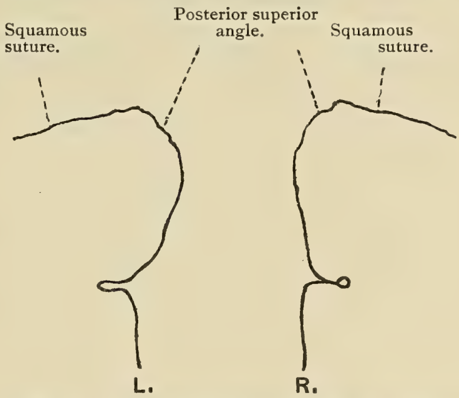

Fig. 36. The posterior parts of the temporal squamæ of a young Virginia Deer (No. 8121, A. M. N. H.), showing different stages of the formation of a fissure from a foramen.

Of the following figures the first shows the process of formation of a fissure to a foramen, as actually observed on the two sides in the temporal bone of a young Virginia deer. (Fig. 36.) The second figure shows the middle two thirds of the right temporo-parietal articulation in an adult dog. In this case an apparently large slit, a short distance beyond which is situated a small foramen, has been filled by a Wormian bone and by an irregular rounded piece of bone now united with the parietal. (Fig. 37.) The third figure is a schema of the several varieties of divisions and spines from and to foramina, which can be observed in full-grown individuals. (Fig. 38.) The fourth figure shows a division in an

Fig. 37. The middle two thirds of the right temporo-parietal suture and the squama underneath, in an adult native dog from British Columbia (No. 13,773, A. M. N. H.), showing an irregular defect in the bone (A), now filled with a small separate bone, and a marginal defect in the squama (B), now filled with a portion of the parietal bone. Both defects, and probably the underlying foramina, are remnants of a former fissure in the squama.

oryx, which is continued from a notch in the parietal border to three parietal foramina. (Fig. 39.)

The appended list gives in detail the various divisions found in the parietal bones of different mammals below man and monkeys. The extent of the material made it imperative to use certain abbreviations in the records; the index of the abbreviations is given at the head of the table.

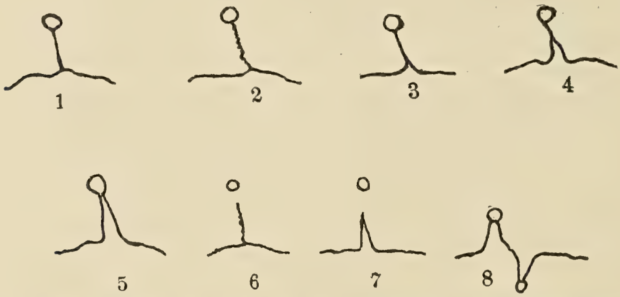

Fig. 38. Divisions and Spines from and to Foramina on the Parietal, Temporal, and other Cranial Bones in Mammals and Man. 1, simple fissure from a foramen to the border of the bone; 2, suture; 3, fissure and a small spine; 4, fissure and a spine of moderate size; 5, complete spine; 6, incomplete suture; 7, incomplete spine; 8, double spine.

Fig. 39. The postero-inferior portion of the parietal bone of an Oryx (No. 13,552, A. M. N. H.), showing, S, a spine filling a cleft in the border of the parietal bone, and above that a suture, running to three superimposed foramina.

FISSURES AND SUTURES TO FORAMINA IN THE PARIETAL BONE IN ANIMALS.

Abbreviations.

f = linear fissure.
ff = multiple linear fissure.
f sp = fissure with a spine in its mouth.
s = suture, incomplete, not ending in a foramen nor directed to it.
s d = incomplete suture directed to a foramen.
s f = " " ending in a foramen.
s sp = " " with a spine in its mouth.
sp. = spine.
sp f = " to a foramen.
$\frac{1}{3}$ = at the end of the first or upper (coronal and l'd) third of the suture.
$\frac{2}{3}$ = " " " " " middle third of the suture.
$\frac{3}{4}$ = " " " " " third fourth " " "
m = at middle.
r = right.
l = left.
v. or vert. = vertical.
h. or hor. = horizontal.
o. or obl. = oblique.
1.0 = 1.0 cm. long.
b. s. = both sides.
bil. = bilateral.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Carnivora : Ursidæ. U. americanus.				
(1) 3762,[1] adol.	—	—	—	—
(2) 5045, "	—	—	sp f, 0.3, r, vert., $\frac{3}{4}$	—
(3) 14053, ad.	—	—	—	—
(4) 5044, adol.	—	—	—	—
(5) 3767, "	—	—	—	—
(6) 49, ad.	—	—	—	—
(7) 7376, "	—	—	—	—
(8) 6639, young	ff, b. s., 0.2 to 0.4	ff, b. s., 0.2 to 0.5	—	—
(9) 4282, "	—	—	—	—
(10) 11136, "	ff, b. s., 0.1 to 0.3	ff, b. s., 0.1 to 0.3,	—	—
(11) 14504, adol.	—	ff, l., 0.1 to 0.3	—	—
(12) 8580, ad.	—	—	sp. f, 0.2, r, v. near lamb. suture.	—
(13) 7374, ad.	—	—	sp f, 0.2, r, v, near lamb. suture.	—
(14) 11167, adol.	—	—	sp f, 0.3, r, o, $\frac{2}{3}$	—
(15) 6283, "	—	—	—	—
(16) 2000, "	—	—	—	—
(17) 6292, ad.	—	—	—	—
(18) 13964, adol.	—	—	—	—
(19) 280, ad.	—	—	—	—
(20) 116, "	—	—	—	—
Black Bear (20)	Multiple fissures in 2 young.	Multiple fissures in 2 young and 1 adolescent.	Short spine, to a foramen, in the last $\frac{1}{3}$ of the bone, in 3, 2 adolescents and 1 adult.	—
U. maritimus.				
(1) No number, adol.	—	—	—	—
(2) 50, adol.	—	—	—	—
(3) 5031, "	sp, 0.7, r., 0.5 from Bg.	—	—	—
(4) 5032, ad.	—	—	s f, 0.2, l, near lamb. s.	—
(5) 56, "	—	—	s f, 0.3, r, $\frac{2}{3}$	—
(6) 55, "	—	—	—	—
(7) 290, "	—	—	—	—
(8) 14054, "	—	—	—	—
(9) 11051, "	—	—	—	—
(10) 10240, "	—	—	—	—
Polar Bear (10)	A spine, in 1, into the parietal on right near bregma (adolescent.)	—	Short suture, to a foramen, in the last $\frac{1}{3}$ of the bone, in 2 adults.	—

[1] All the specimens here referred to are from the Zoölogical Collection of the American Museum of Natural History, New York.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Felidæ.				
F. leo				
(1) 13904, adol.	—	—	—	—
(2) 13998, "	—	—	—	—
(3) 8355, young	—	—	f, 0.2, b. s., into the mastoid angle.	—
(4) 6259, "	—	—	—	—
(5) fœtus at term.	—	—	—	—
(6) " " "	—	—	f, b. s., 0.3, into mast. angle.	—
(7) " " "	—	—	f, b. s., 0.2 & 0.1, into mast. angle.	—
(8) " " "	—	—	f, b. s., small, into mast. angle.	—
(9) " " "	f, 0.8, r. $\frac{1}{3}$	—	—	—
(10) " " "	—	—	f, 0.4, b. s., into mast. angle.	—
Lion (10)	A fissure, in 1 fœtus, on right side, below the upper $\frac{1}{3}$ of the parietal bone.	—	In 4 fœtuses and 1 young a fissure in each mastoid angle of the parietal.	—
F. tigris.				
(1) 61, ad.	—	—	—	—
(2) 63, "	—	—	—	—
(3) ? "	—	—	—	—
(4) 62, "	—	—	—	—
(5) 298, near ad.	—	—	—	—
(6) 10556, ad.	—	—	—	—
(7) fœtus at term.	—	—	—	—
(8) " " "	—	—	—	—
(9) " " "	—	—	—	—
(10) " " "	—	—	—	—
Tiger (10)	—	—	—	—
F. onca.				
(1) ? adol.	—	—	—	—
(2) 6293, "	—	—	—	—
(3) 68, "	—	—	—	—
(4) 6354, "	—	—	—	—
(5) 11086, "	—	—	—	—
(6) 64, "	—	—	—	—
(7) 11085, near ad.	—	—	—	—
(8) 6246, ad.	—	—	—	—
(9) 11083, near ad.	—	—	—	—
(10) 11084, "	—	—	—	—
Jaguar (10)	—	—	—	—
F. concolor.				
(1) 6295, young	—	—	—	—
(2) 1334, adol.	—	—	—	—
(3) 6249, "	—	—	—	—
(4) 1323, ad.	—	—	—	—
(5) 1331, near ad.	—	—	—	—
(6) 1339, "	—	—	—	—
(7) 6677, ad.	—	—	f sp, 0.8, l., $\frac{3}{4}$	—
(8) 1337, near ad.	—	—	—	—
(9) 1336, adol.	—	—	f sp, 0.5, r., $\frac{4}{5}$	—
(10) 1340, "	—	—	—	—
(11) 10259, "	—	—	—	—
(12) 1338, ad.	—	—	—	—
(13) 1327, adol.	—	—	—	—
(14) 117, ad.	—	—	—	—
(15) 5034, adol.	—	sp, 1.7, l, obl., fr. obelion.	s, 1.5, r., sq. to lamb.	—
Puma (15)	—	In 1, adolescent, a suture to a foramen, on left, from obelion.	In 2 spine and fissure in the last $\frac{1}{4}$: in one a suture separating a portion of the mastoid angle.	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
F. pardalis.				
(1) 14022, near ad.	—	—	—	—
(2) 13960, "	—	—	—	—
(3) 10073, "	—	—	—	—
(4) 10507, adol.	—	—	—	—
(5) 69, near ad.	—	—	—	—
(6) 2100, ad.	—	—	—	—
(7) 354, adol.	—	—	—	—
(8) 6248, near ad.	—	—	—	—
(9) 5938, adol.	—	—	—	—
(10) 11039, "	—	—	A suture, slightly serrated throughout, fr. sq. at pterion over whole r. pariet. and 0.8 over l. par.; (*v.* Part *V.*)	—
(11) 4318, adol.	—	—	—	—
(12) 5369, ad.	—	—	—	—
(13) 6250, adol.	—	—	—	—
(14) 6406, "	—	—	—	—
(15) 352, ad.	—	—	—	—
(16) 5518, near ad.	—	—	—	—
(17) 72, adol.	—	—	—	—
(18) 13917, "	—	—	—	—
(19) 2087, near ad.	—	—	—	—
(20) 13999, young	—	—	—	—
Ocelot (20)	—	—	In 1 a complete vertical division of the right and incomplete division of the left parietal bone.	—
F. canadensis.				
(1) 1349, young	—	—	—	—
(2) 237, "	—	—	—	—
(3) 1351, "	—	—	—	—
(4) 1343, adol.	—	—	—	—
(5) 1962, "	—	—	—	—
(6) 1345, "	—	—	—	—
(7) 535, "	—	—	—	—
(8) 6420, ad.	—	—	—	—
(9) 1350, "	—	—	—	—
(10) 1352, adol.	—	—	—	—
(11) 1954, "	—	f, 0.8, l, at the height of the tempor. ridge, a depression towards obelion.	—	—
(12) 8624, near ad.	—	—	—	—
(13) 1953, "	—	—	—	—
(14) 70, ad.	—	—	—	—
(15) 2443, near ad.	—	—	—	—
(16) 2851, ad.	—	—	—	—
(17) 4606, near ad.	—	—	—	—
(18) 1958, "	—	—	—	—
(19) 1961, "	—	—	—	—
(20) 2187, ad.	—	—	—	—
Lynx (20)	—	In 1 adol. a separated segment of a fissure, on left, along the temporal ridge.	—	—
Felis catus.				
(1) 3778, ad.	—	—	—	—
(2) 3799, near ad.	—	—	—	—
(3) F. domestica, 3778, ad.	—	—	—	—
(4) F. domestica, 71, ad.	—	—	—	—
(5) " " 1963, ad.	—	—	—	—
(6) F. domestica, 11151, near ad.	—	—	—	—
(7) F. domestica, 11152, ad.	—	—	—	—
(8) F. domestica, 1964, near ad.	—	—	—	—
(9) F. domestica, 10289, ad.	—	—	—	—
(10) F. domestica, 11266, young	—	—	—	—
Cat, wild and domestic (10)	—	—	—	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Hyænas.				
(1) H. macul., 8304, v. young	—	—	f l. 0.6, r. 0.8, curved, in the sphenoidal angle; a small fiss. on each side in the mastoid angle.	f, small, b. s., 0.6 above asterion
(2) H. macul., 971, young	—	—	f 10.3, ab. sphen. angle.	—
(3) H. ? 615, adol.	—	—	—	—
(4) " str. 1544, n. ad.	—	—	—	—
(5) " " 67, ad.	—	—	—	—
Hyænas (5)	—	—	In 1 young a fissure into the sphenoidal angle, in another young slightly above it. In 1 young a fissure into each mastoid angle.	In 1, young, a fissure on both sides slightly above asterion.
Canidæ.				
(1) C. famil., very young	—	—	—	—
(2) " " " "	—	—	—	—
(3) " " " "	—	—	—	—
(4) " " " "	—	—	—	—
(5)	—	—	—	—
(6) C. famil., 1203, adol.	—	—	—	—
(7) " " 11013, ad.	—	—	—	—
(8) " " 78, adol.	—	—	—	—
(9) " " 11105, ad.	—	—	—	—
(10) " " 408, ad.	—	—	—	—
(11) C. ? 13681, ad.	—	—	—	—
(12) C. fam., 115, ad.	—	—	—	—
(13) " " 77, "	—	—	—	—
(14) C ?	—	—	—	—
(15) C. Brit. Col., adol.	—	—	—	—
(16) " " " (13773), ad.	—	—	—	—
(17) C. Mexic., ad.	—	—	—	—
(18) " " adol.	—	—	—	—
(19) " Esquimo, ad.	—	—	—	—
(20) " " adol.	—	—	—	—
Dog (20)	—	—	—	—
Vulpes lagopus.				
(1) 10207, ad.	—	—	—	—
(2) 82, "	—	—	—	—
(3) 10227, adol.	—	—	—	—
(4) 10170, ad.	—	—	—	—
(5) 10173, ad.	—	—	—	—
(6) 10691, "	—	—	—	—
(7) 10228, near ad.	—	—	—	—
(8) 10175, ad.	—	f, r., 0.3, sup.-post. angle, continues on interpar. for 0.3.	—	—
(9) 10228, near ad.	—	depression, in same location, on left.	—	—
(10) 10232, ad.	—	depression, in same location, on r., ending in a minute foramen, 0.4 in toto.	—	—
Arctic Fox (10)	—	In 3 a depression, or a fissure, in the lambdoidal angle of the parietal.	—	—
Vulpes fulvus.				
(1) 6413, young	—	—	—	—
(2) 6412, "	—	—	—	—
(3) 6369, "	—	—	f, small, into each mastoid angle.	—
(4) 3796, "	—	—	f, small, into each mastoid angle.	—
(5) 6415, "	—	—	—	—
(6) 11809, "	—	—	—	—
(7) 6414, "	—	—	—	—
(8) 3749, adol.	—	—	—	—
(9) 4279, "	—	—	—	—
(10) 11066, ad.	—	—	—	—
American Red Fox (10)	—	—	In 2 young a small fissure in each mastoid angle of the parietal.	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Canis lupus gris.-alb.				
(1) 111, adol.	—	—	—	—
(2) ? ad.	—	—	—	—
(3) 2384, "	—	—	—	—
(4) 4609, "	—	—	—	—
(5) 76, "	—	—	—	—
(6) 458, "	—	—	—	—
(7) 112, n. ad.	—	—	—	—
(8) 481, ad.	—	—	—	—
(9) 5381, adol.	—	—	—	—
(10) 2247, ad.	—	—	—	—
Gray Wolf (10)	—	—	—	—
Canis latrans.				
(1) very young	—	—	—	b. s. depression, abt. m., running towards the eminence.
(2) " "	—	—	—	b. s. depression, abt. m., running towards the eminence.
(3) " "	—	—	—	b. s. depression, abt. m., running towards the eminence.
(4) " " 9582	—	l., $f_{\frac{4}{5}}$, 0.7, nearly vert.	—	b. s. depression, abt. m., running towards the eminence.
(5) young	—	—	—	depression, b. s., n. middle.
(6) " 14489	—	traces of 1.1 obl. f. on r., $\frac{1}{2}$, and of a f. 0.45, l. $\frac{3}{4}$	—	depression, n. m., marked.
(7) " 14488	—	depression ov. both pariet's, beginning at middle.	—	—
(8) "	—	—	—	marked depression on each side, fr. m. towards eminence.
(9) adol.	—	—	—	—
(10) ad.	—	—	—	—
(11) 2846, near ad.	—	—	—	—
(12) 3753 ad.	—	—	—	—
(13) 5383, adol.	—	—	—	—
(14) 5385, near ad.	—	—	—	—
(15) 3739, ad.	—	—	—	—
Coyote (15)	—	Fissure, in the post. $\frac{1}{3}$ of the parietal, in 2 young.	—	A depression probably the remnant of a fissure, about the middle of the occipital border of the parietal, in almost all young.
Carnivora. (195)	Multiple fissures in 2 black bears, young; A spine in 1 adol. polar bear; A fissure in 1 lion fœtus.	Multiple fissures in 3 black bears; Suture to a foramen in 1 puma; Segment of a fissure in 1 lynx; Fissure or a depression in the lambdoid angle in 3 arctic foxes; Fissure from obelion in 2 young coyotes.	Fiss. in sphenoidal angle in 2 hyænas; Spine to a foramen in 3 black bears; Suture to a foramen in 2 polar bears; Fiss. in mastoid angle in 5 lions, 1 hyæna, 2 red foxes (all young). Spine and fiss., post. $\frac{1}{4}$, of par., 2 pumas. Separation of part of mastoid angle, 1 puma. Division of whole parietal, 1 ocelot.	Fissure, above asterion, in 1 young hyæna; Depression, at middle, in 7 young coyotes.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Ungulata.				
(1) Ovis tragelaphus, 10707, v. young	Several small incisures in the squam. portion which underlies the frontal.	o.9 f. on each side, $\frac{1}{3}$ o.4 f. on each side, just before this, o.4 f. on each side, beyond m.	—	—
(2) Ovis tragelaphus, 6360, young	—	—	f, l., o.5, m.	f, o.2, r., post-inf. angle.
(3) Ovis musim., 6294, adol.	—	—	—	—
(4) Ovis montana, 14004, ad.	—	—	—	—
(5) Ovis musim., 6233, adol.	—	—	—	—
(6) Ovis ? 6358, ad.	—	—	—	—
(7) " ? 6238, "	—	—	—	—
(8) " tragelaph, 10261, ad.	—	—	—	—
(9) Ovis tragelaph, 10260, ad.	—	—	—	—
(10) Ovis trage., 11019, adol.	—	—	—	—
(11) Ovis ? 5028, ad.	—	—	—	—
(12) Ovis aries 6361, ad.	—	—	—	—
(13) Ovis aries, 10262, ad.	—	—	—	—
(14) " " 14083, "	—	—	—	—
(15) " ?, v. young	f, b. s., ab. sphen. angle.	—	—	small f. in each mastoid angle.
(16) " stonei, ad.	—	—	2 sp. to for., $\frac{4}{5}$	—
(17) " stonei, ad. 11052	—	—	sp. f, small, r., $\frac{5}{6}$	—
(18) Ovis stonei, ad. 12719	—	—	f for, r., o.3, near aster. f for l., o.7, near aster.	— —
(19) O. montan., 13793, near ad.	—	—	—	— —
(20) ? 6232, young	—	7 f., b. s., o.3 to o.5	f, l., o.4, m.	
Sheep (20)	Several fissures in 1 young. Fiss. above each sphenoidal angle in 1 young.	Multiple fiss. in 1 young. 6 fiss. in 1 young.	In 1 a fissure at mid. In 2 a spine to a foramen. In 1 a fissure to a foramen.	In 2, young, fissure in the mastoid angle.
(1) Capra res., 2074, v. young	—	—	—	f, b.s., ab. mastoid angle.
(2) Capra ?, 10728, v. young	—	—	—	—
(3) Capra ?, 6237, young	—	—	—	—
(4) " ? 6236, "	—	—	f for, l., o.2, $\frac{4}{5}$	—
(5) Capra angora, 8360, young	—	—	—	—
(6) Capra angora, 6359, ad.	—	—	f for, l., o.2, $\frac{4}{5}$	—
(7) Capra angora, 10268, ad.	—	—	—	—
(8) Capra angora, 8354 ad.	—	—	s f, r., o.3, $\frac{3}{4}$	—
(9) Capra angora, 2083, ad.	—	—	—	—
(10) Capra ?, ad.	—	—	—	—
Goats (10)	—	—	In 2 young a fissure to a foramen; in one adult a suture to a foramen, all in last $\frac{1}{4}$ of the parietal.	In 1 a fissure on each side in the mastoid angle.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Cervidæ.				
Alces amer.				
(1) 6408, near ad.	—	—	sp f, b. s., $\frac{3}{4}$, large, on left double.	—
(2) 3796, adol.	—	—	s f, r., 0.3, $\frac{2}{3}$	—
Cervus canadensis.				
(1) 6351, young	—	—	—	—
(2) 209, ad.	—	—	—	—
(3) 5037, adol.	—	—	—	—
(4) 368, near ad.	—	—	—	—
Rangifer groenl.				
(1) 14237, ad.	—	—	—	—
(2) 14233, "	—	—	—	—
(3) 14239, young	—	—	—	—
Rangifer tarandus.				
(1) 5035, young	—	—	—	—
(2) 5141, ad.	—	—	—	—
(3) 3460, near ad.	—	—	—	—
Elks and Rangifers (12)	—	—	In one elk a spine to a foramen, in the other a suture to a foramen, both in the last $\frac{1}{3}$ of the parietal.	—
Dorcelaphus hemion.				
(1) 13903, ad.	—	—	—	—
(2) 11109, "	—	—	sp f, r., 0.6, $\frac{3}{4}$	—
(3) 12792, "	—	—	3 small sp to for. on l., 1 on right.	—
(4) 11142, near ad.	—	—	s f, 1 on l., 2 on r., small, $\frac{2}{3}$.	—
(5) 11143, adol.	—	—	sp f, small, l., $\frac{2}{3}$.	—
(6) 11116, ad.	—	—	—	—
(7) 11141, adol.	—	—	sp f, r., $\frac{2}{3}$	—
(8) 11118, ad.	—	—	sp f, b. s., $\frac{3}{4}$	—
(9) 11139, "	—	—	2 sp f on r., $\frac{3}{4}$	—
(10) 11114, near ad.	—	—	f for. on l., sp f on r., $\frac{2}{3}$	—
Dorcelaphus. (10)	—	—	Spine to a foramen in 6; fissure to a foramen in 1; suture to a foramen in 1.	—
Cervus elaphus.				
(1) 13911, v. young	—	—	f, 2 on l., 1 on r., $\frac{2}{3}$ (0.2 to 0.4).	—
(2) 10713, young	—	—	—	—
(3) 10076, ad.	—	—	—	—
(4) 141, near ad.	—	—	2 sp f., small, on l., $\frac{2}{3}$.	—
(5) 142, ad.	—	—	3 sp f, small, on r., $\frac{2}{3}$	—
Red Deer (5)	—	—	Spine to a foramen in 2. Fissure in 1 young.	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Cervus virgin.				
(1) 10706, adol.	—	—	f for, b. s., 0.9, $\frac{2}{3}$	—
(2) 14084, "	ff, 0.1 to 0.3, b. s. of bregma.	—	f, l., 0.7, partly occluded, $\frac{3}{4}$	—
(3) 3764, near ad.	a number of small, f on both sides of bregma.	—	f for, 0.2, l., near sphen. angle.	—
(4) 3766, ad.	—	—	—	—
(5) 8363, near ad.	—	—	f for, 0.5, l., $\frac{3}{4}$, on r. a depression.	—
(6) 3798, v. young	—	—	f, 0.3, in each mastoid angle.	f, l., 0.2, r., 0.5, 1.1 fr. lda.
(7) 11144, ad.	—	—	r. sp f for, $\frac{3}{4}$	—
(8) 11028, ad.	—	—	f for, b. s., 0.8, $\frac{3}{4}$, sp in base; on r., for. obliterated.	—
(9) 3777, "	—	—	sp and depression to for. b. s., $\frac{3}{4}$	—
(10) 7368, "	—	—	depression to for., b. s., $\frac{3}{4}$.	—
(11) 812, v. young	—	—	(depression.)	—
(12) 2838, "	—	—	(depression.)	b. s., marked cleft, above mastoid angle.
(13) 2078, young	ff, on both sides of bregma.	—	(depression.)	—
(14) 10290, "	—	—	(depression.)	—
(15) 10514, adol.	—	—	sp and depression, b. s., $\frac{3}{4}$	—
Virginia Deer (15)	Multiple fissures in 3.	—	Fissure in 2; fiss. to a foramen in 4; depression to a for. 6; spine and depress. to a for. 2; spine and fissure to a for. 1. In 1 —.	In 1 young a fissure in mastoid angle, in 1 y. a fissure below upper $\frac{1}{5}$.
Cervus axis.				
(1) 11165, v. young	—	—	f, b. s., 0.2, $\frac{2}{3}$	—
(2) 13961, young	—	—	—	—
(3) 10710, near ad.	—	—	—	—
(4) 3765, ad.	—	—	—	—
(5) 10553, ad.	—	—	depression, on left traces, on r. deep; connects two foramina-vascular.	—
Axis Deer (5)	—	—	In 1 a fissure on both sides; in 1 a depression.	—
Cervus dama.				
(1) 6365, v. young	—	—	—	—
(2) 10714, "	f, 0.4, r., m. (hidden beneath the squama of the frontal.	—	s, b. s., 0.3, in the sphen. angle.	f, 0.2, r., $\frac{1}{3}$
(3) 10718, "	—	—	f, 0.4, b. s., near middle, hidden under tempor. squama.	f, 0.2, r., $\frac{1}{3}$
(4) ? "	f, 0.2, b. s., near m. (hidden). f, in each bregma angle.	—	depression; l. suture in sphen. angle; trace on right.	—
(5) 11036, young	ff, on both sides of bregma.	—	—	—
(6) 11157, "	—	—	—	—
(7) 8359, "	—	—	(depression.)	—
(8) 10272, ad.	—	—	(depression.)	—
(9) 10257, "	—	—	(depression.)	—
(10) 10079, "	—	—	(depression) left.	—
Fallow Deer (10)	Multiple fissures in 1 young. Fissure in middle in 2. Fissure in each bregmatic angle in 1 young.	—	Suture in sphenoidal angle in 2; fissure near middle in 1; depression in 5.	Fissure, below the upper $\frac{1}{3}$ of the parietal, in 2.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Arizona Deer.				
(1) 3, adol.	—	—	—	—
(2) 1976, ad.	—	—	—	—
(3) 1972, "	—	—	—	—
(4) 1966, near ad.	—	—	—	—
(5) 2, adol.	—	—	—	—
Arizona Deer (5)	—	—	—	—
Coassus (Trinidad).				
(1) 375, ad.	—	—	—	—
(2) 146, "	—	—	—	—
(3) 145, "	—	—	—	—
(4) 147, "	—	—	depression, $\frac{2}{3}$	—
(5) 377, "	—	—	—	—
Coassus Deer (5)	—	—	A depression at the end of second third in 1.	—
Antilocapridæ. Antilocapra amer.				
(1) 11133, near ad.	—	—	—	—
(2) 11105, ad.	—	—	—	—
(3) 11130, "	—	—	f for., small, r., $\frac{3}{4}$	—
(4) 11099, "	—	—	—	—
(5) 11134, "	—	—	—	—
(6) 11104, "	—	—	—	—
(7) 11100, near ad.	—	—	sf, r., 0.4, near asterion.	—
(8) 11096, ad.	—	—	—	—
(9) 11107, "	—	—	—	—
(10) 11128, adol.	—	—	—	—
American Antelope (10)	—	—	Fiss. to foramen in 1; Suture to foramen in 1; both in the last $\frac{1}{4}$ of the parietal.	—
Antilopidæ. Antilope cervicapra.				
(1) 12049, young	—	—	depress. to for. b. s., $\frac{3}{4}$ (vascular depression).	—
(2) 10741, adol.	—	—	depress. to for. b. s., $\frac{3}{4}$ (vascular depression).	—
(3) 13913, young	—	—	depress. to for. b. s., $\frac{3}{4}$ (vascular depression).	—
(4) 11029, ad.	—	—	depress. to for. b. s., $\frac{3}{4}$ (vascular depression).	—
(5) 10708, adol.	—	—	depress. to for. b. s., $\frac{3}{4}$ (vascular depression).	—
Common Antelope (5)	—	—	A vascular depression from a foramen under the squama, on the last $\frac{1}{4}$ of the parietal in all.	—
Madoqua.				
(1) 13540, ad.	—	—	—	—
(2) 13538, "	—	—	—	—
(3) 13541, "	—	—	—	—
Madoqua (3)	—	—	—	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Oryx.				
(1) 10724, ad.	—	—	sp f, b. s., small, $\frac{4}{5}$	—
(2) 14115, "	—	—	f for, 0.4, b. s., near aster.	—
(3) 13552, "	—	—	sp f to a chain of 3 foramina, r., $\frac{4}{5}$	—
(4) 10080, near ad.	—	—	f for, small, b. s., near aster.	—
Oryx (4)	—	—	Spine or a fissure to a foramen in all, in last $\frac{1}{5}$ of the parietal.	—
Nylghai.				
(1) 5024, ad.	—	—	—	—
(2) 166, "	—	—	large depression, vascular, near asterion.	—
(3) 14095, ad.	—	—	large depression, vascular, near asterion.	—
Nylghai (3)	—	—	In 2 a large, bilateral, vascular groove near the asterion.	—
Boselaphus tragocam.				
(1) 12412, v. young	f, b. s, small, ab. sphen. angle, also a f, b. s., next to bregma.	—	f, b. s. 0.3, into mastoid angle.	—
(2) 11035, young	—	—	depression, $\frac{2}{3}$	—
(3) 11168, "	—	—	depression, $\frac{2}{3}$	—
(4) 11169, ad.	—	—	depression, $\frac{3}{4}$	—
(5) 13797, "	—	—	—	—
Boselaphus trag. (5)	In 1 young fissures above the sphenoidal angle and near bregma.	—	In 1 young fissure in mastoid angle: In 3 vascular grooves in the last $\frac{1}{3}$ of the parietal.	—
Bubalis swaynei.				
(1) 13536, young	—	—	—	—
(2) 13537, ad.	—	—	—	—
(3) 14443, "	—	—	—	—
Bubalis swaynei (3)	—	—	—	—
Bovidæ.				
(1) Bos grunniens, adol.	—	—	—	—
(1) " caffer, ad.	—	—	—	—
(2)	—	—	—	—
(1) Bison amer. ad.	—	—	—	—
(2) " " "	—	—	—	—
(3) " " "	—	—	—	—
(4) " " "	—	—	—	—
(5) " " adol.	—	—	—	—
Bison (5)	—	—	—	—

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Bos indicus. (1) v. young	f, b. s., in bregma. angle.	—	f, b. s., in sphen. angle.	—
(2) 6403, young	f, b. s., in bregma. angle.	—	—	—
(3) 10080, "	f, b. s., in bregma. angle.	—	—	—
(4) 6357, "	f, b. s., in bregma. angle.	—	—	—
(5) 10500, ad.	—	—	—	—
Indian Bull (5)	In 4 young a fissure on each side in the bregmatic angle.	—	In 1 young fissure on each side in the sphenoidal angle.	—
(1) Bos taurus, ad.	—	—	—	—
(2) " " "	—	—	—	—
(2)	—	—	—	—
Other Ungulates. *Equidæ.* (1) Equus 295, adol.	—	—	—	—
(2) " 140, "	—	—	—	—
(3) Burro, "	—	—	—	—
(4) Zebra, "	—	—	—	—
Horses (4)	—	—	—	—
Camelidæ (1) Camel, 14124, ad.	—	—	—	—
(2) " 6368, young	f, b. s., beneath the spine.	f, b. s., 0.8, $\frac{2}{3}$	f, b. s., 0.4, $\frac{2}{3}$	f, b. s., above mastoid angle.
(3) Camel, 10271, young	f, b. s., small.	ff, small, ant. $\frac{1}{3}$	—	f, b. s., on right.
(4) Llama, 14121, ad.	—	—	—	—
(5) " 5140, near ad.	—	—	—	—
(6) " 6235, young	—	—	—	—
Camels and Llamas. (6)	In 2 young a fissure on each side below the temporal ridge.	In 1 young multiple fissures; in 1 young a fissure at about the obelion.	In 1 young a fissure on each side between the second and last thirds of the parietal.	In 2 young a fissure above the mastoid angle.
Suidæ. (1) S. scrofa, young	—	—	f, b. s., small, in mast. angle.	f, b. s., small, above mastoid angle.
(2) S. scrofa, domest., 10739, adol.	—	2 small f on each side $\frac{2}{3}$	—	—
(3) S. scrofa, domest., 10740, adol.	f, b. s., ab. temp. r. f, 0.6, r. sphen. angle.	—	—	—
(4) S. scrofa, 387, n. ad.	—	—	—	—
(5) " 14126, "	—	—	—	—
(6) " 14124, "	—	—	—	—
Boars and Pigs (6)	In 1 adolesc. a fissure on each side above the temporal ridge, and another in the right sphenoidal angle.	In 1 adoles. 2 fissures, at the end of the 2d third of the border.	In 1 young a fissure on each side in the mastoid angle.	In 1 young a fissure on each side above the mastoid angle.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Ungulata (160)	Multiple fissures in upper $\frac{1}{3}$ of the frontal border of the parietal bone, in: 1 young sheep, 3 subadult Virginia deer, 1 fallow deer. Fissure in the super.-anterior angle, in: 1 young fallow deer, 4 young Bos indic. Fissure near bregma, in: 1 young Boselaphus. Fissure near the temporal ridge, in: 2 young camels, 1 adol. pig. Fissure at middle, in: 2 young fallow deer. Fissure above the sphenoidal angle, in: 1 young sheep, 1 young Boselaphus, 1 adolesc. pig.	Multiple fissures, in: 1 young camel, 1 adol. pig. Fissure at first $\frac{1}{3}$ in 1 Ovis tragel. Fissure at second $\frac{1}{3}$ (about obelion), in 1 young camel.	Fissure at middle, in: 1 Ovis tragel., 1 y. fallow deer. Fissure at $\frac{2}{3}$, in: 1 young red deer, 1 y. axis, 1 y. camel. Fissure at $\frac{3}{4}$ or near asterion, in: 1 adol. Virginia deer. Fissure or suture in sphenoidal angle in: 2 y. fallow deer, 1 y. Bos indicus. Fiss. in mastoid angle, in: 1 y. Virginia deer, 1 y. Boselaphus, 1 y. pig. Fiss. to a foramen, in: 1 Ovis stonei (near aster.), 3 goats ($\frac{4}{5}$), 1 Dorcelaphus ($\frac{2}{3}$), 4 Virginia deer ($\frac{1}{5}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{3}{4}$), 1 Amer. antelope ($\frac{3}{4}$), 2 Oryx (near aster.). Suture to a foram., in: 1 goat ($\frac{3}{4}$), 1 elk ($\frac{2}{3}$), 1 Dorcelaphus ($\frac{2}{3}$), 1 Amer. antelope (near aster.). Spine to a foramen, in: 2 sheep ($\frac{4}{5}$, $\frac{5}{6}$), 1 elk ($\frac{3}{4}$), 6 Dorcelaphi ($\frac{2}{3}$, $\frac{3}{4}$), 2 red deer ($\frac{2}{3}$), 3 Virgin. deer (2 with a depression, $\frac{3}{4}$, 1 with a fissure, $\frac{3}{4}$), 2 Oryx ($\frac{4}{5}$). Vascular depression, in: 8 Virginia deer ($\frac{3}{4}$), 1 axis, 5 fallow deer, 1 Coassus, 5 Antilope cervicapra, 2 nylghai, 3 Boselaphi.	Fissure in poster.-infer. or mastoid angle: 2 young sheep. Fissure a small distance above mastoid angle: 1 young goat, 1 young Virginia deer, 2 young camels, 1 young pig. Fissure at the end of the upper $\frac{1}{3}$ of the occipital border, in: 2 young fallow deer. Fissure near lambda: 1 young Virginia deer.

	From Coronal Suture.	From Sagittal Suture.	From Squamous Suture.	From Lambdoid Suture.
Pinnipedia.				
Eleven Phoca grœnl.	—	—	—	—
Ten " fœtida	—	—	—	—
One " "	On each side several fissures above the sphenoidal angle, one almost dividing the angle.	—	—	—
Seven " vitulina	—	—	—	—
Six Zalophus calif.	—	—	—	—
One " "	2 small fiss. ab. sphen. angle. 1 suture to a for. above r. sphen. angle.	—	—	—
One " "	1 fiss. above l. sphen. angle.	—	—	—
One " " young	large fissure, ab. the sph. angle.	—	—	—
Two Seals (spec. ?)	fissure above the sphen. angle.	—	—	—
Six " "	—	—	—	—
Six Walrus	—	—	—	—
Pinnipedia (52)	In some seals and Zalophi one or more fissures above the sphenoidal angle of the parietal bone.	—	—	—
Rodentia.				
Six Castor fiber.	—	—	—	—
Thirty " canad.	—	—	—	—
One Fiber zibeth.	—	—	—	—
One Lepus camp.	—	—	—	—
One Hystrix lucar.	—	—	—	—
Thirty Sciurus huds.	—	—	—	—
Twenty Cynomys	—	—	—	—
Twenty-five Arctomys	—	—	—	In a few cases a spine from the occipital, below the interparietal bone.
Thirty Spermophilus	—	—	—	—
Twenty Muridæ	—	—	—	—
One Mus, y.	—	—	bilatreal fissure, from squamous suture, about middle, towards the lambdoid suture, up to ½ the distance.	—
Twenty Neotoma mex.	—	—	—	—
Rodents. (185)	—	—	In 1 a bilateral oblique fissure (young rat).	In a few marmots a spine from the occipital into the parietal bone, below the interparietal.

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Article IX. — ADAPTIVE SIGNIFICANCE OF THE SHORTENING OF THE ELEPHANT'S SKULL.

By W. K. Gregory.

Plate XXIII and 4 Text Figures.

The following observations were made in connection with Professor Osborn's forthcoming memoir on American fossil Proboscidea, for which were also prepared the figures here used by his kind permission.

Weithofer [1] regards the changes in the elephant's skull observable during individual growth as well as in phylogeny, such as the compression and vertical heightening and deepening of the skull, the wide separation of the inner and outer tabulæ of the bones, and the cancellous condition of the diploë, the forward shifting of the orbits from a point above the anterior grinders, etc., as primarily correlated with the prodigious development of the tusks — weapons and crow-bars whose effectiveness increased with and reciprocally hastened the phyletic advance in body dimensions. Now the earliest known proboscideans (*Mœritherium*) possessed upper as well as lower incisor tusks, and there are other grounds also for inferring that the ancestors of *Dinotherium* probably possessed upper incisor tusks of small size, even smaller than in the primitive *Mastodon* (*Trilophodon*) *euhypodon;* the presence of these may have initiated the shortening of the head, but the final compression of the skull in *Dinotherium* progressed notwithstanding the reduction and entire disappearance of upper tusks, and this, together with the underlying similarity of its skull to that of *Mastodon* and of *Elephas*, shows that some other factor must also be represented in the extraordinary end results of the process of fore-and-aft compression.

This factor seems to be the development of the proboscis. This unique organ probably owes its existence partly to the shortening reach of the head and neck which took place

[1] Die Fossilen Proboscidier des Arnothales in Toskana. 4to, Wien, 1890.

simultaneously with increasing stature and longer limbs, partly to the necessity of reaching outside the lengthening tusks, partly to the intrinsic advantages of a prehensile organ of such manifold possibilities. On the one hand, we may suppose, the enlargement of the trunk intensified the changes due to the shifting and enlargement of the tusks, and on the other hand inaugurated many of the peculiar conditions described below.

The backward shifting of the weighty tusks and trunk, compensating their adverse leverage, lessened the antero-posterior space available for the grinding series, while the work put upon the individual grinders increased with larger bodies and longer lives. This may explain in part why the simple grinders of *Dinotherium*, with their two, or at most three, low, widely separated ridges, were constrained to evolve into the wonderfully specialized and effective grinders of the Mammoth, with ridges in great number, exceedingly high, and closely appressed, and in which there is a so-called horizontal succession in use, the unworn teeth being pushed into place from behind. The weighty, rapidly heightening molars, together with their immense, backward and upwardly growing alveolar pouch, might thus be regarded as a third factor in the evolution and individual growth history of the skull. It is plain, however, that this factor was a minor one and that the characteristic features of the skull were attained, in great part, before the teeth had become so highly specialized; for the typical *Mastodon americanus*, with its great size, and great tusk-and-trunk development, shows nearly the same degree of backward and downward extension of the posterior nares and hard palate as in *Elephas*, yet retains comparatively primitive low-crowned grinders, and the considerable space between the posterior border of the last molar and the posterior lateral limits of the hard palate in this genus was not nearly so much utilized for storing incoming grinders as it is in *Elephas*.

Principally then, to the enlargement and backward shifting of the trunk and tusks and the consequent fore-and-aft compression of the whole skull, combined with the progressively

widening separation of the inner and outer surfaces of the bones for the sake of lightness and large area for the head muscles, we may ascribe the following morphological conditions, which attain the extreme of specialization in the skull of the Mammoth. In the inferior view of the skull the hard palate, contrary to what obtains in most Ungulates, is tilted somewhat upward; the palatines become reduced antero-posteriorly and shoved backward so as to diverge widely posteriorly; the posterior nares, probably *pari passu* with the anterior nares, have been pushed very far back [1]; the enormous vertical pterygoid wing of the alisphenoid wraps itself around and functionally replaces the hinder end of the encroaching molar-tooth pouch; the foramen ovale of the alisphenoid, which in the most primitive Ungulates is anterior to the foramen lacerum medius, has been shifted obliquely backward and outward, and becomes confluent with it externally (Fig. 1) [2]; the presphenoid, basisphenoid, basioccipital thicken in the median plane and at diminishing rates, the lower tabulæ of these bones growing downward to a less and less extent as we pass backward, so that in the adult the inferior surface of the basis cranii points sharply downward, and forms, with the plane of the back of the occiput, an angle greater than 90°; the tympanic bullæ, relatively large and inflated in the young, flatten down and become closely appressed to the skull, pointing obliquely downward, forward, and inward, with the wider end toward the transversely expanded occipital region (Fig. 1, *Ty.*). In brief, the progressive brachycephaly of the skull has apparently involved not so much a fore-and-aft shortening of the individual elements as a readjustment and modification of them, and secondly an expansion in the transverse vertical planes.

The shortening and deepening of the temporal fossæ, and perhaps to some extent the above-mentioned expansion of

[1] Among the Glyptodonts a similar backward and downward growth of the palate and posterior nares seems to be correlated chiefly with the shortening of the skull, as the anterior nares remain terminal.

[2] This change must have taken place at a very early date in the history of the Proboscidea, as it is already established in the primitive *Mastodon* (*Trilophodon*) *productus* and also, if Kaup's figures are here rightly interpreted, in *Dinotherium*.

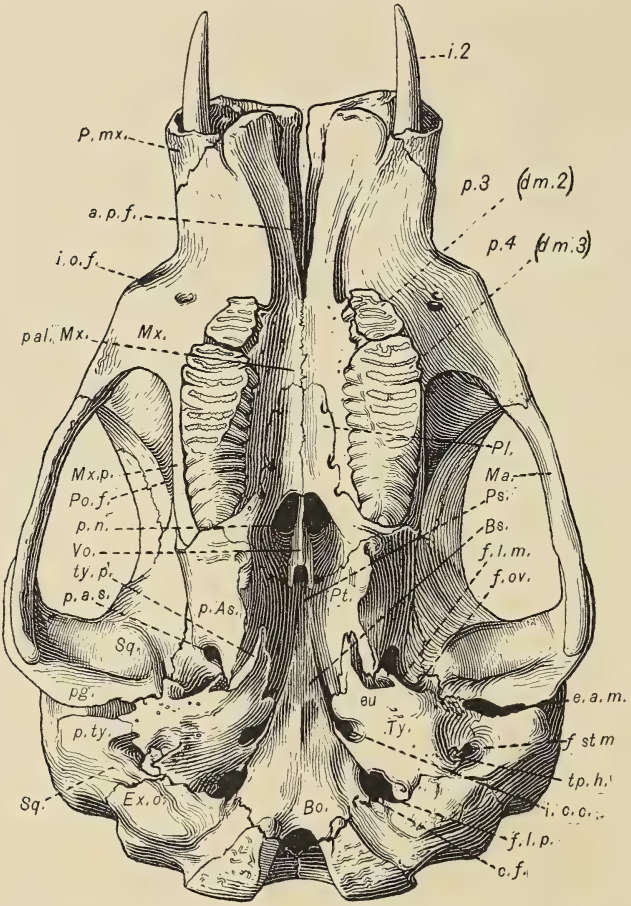


Fig. 1. Inferior view of the skull of a young Asiatic elephant. About $\frac{1}{5}$ nat. size. From a forthcoming memoir by Professor Osborn.

BONES.

P. mx.—Premaxillary.
Mx.—Maxillary.
Mx. p.—Maxillary pouch for molars.
Ma.—Malar.
Po.f.—Postorbital ridge of frontal.
pal. Mx.—Palatine ledge of maxillary.
Pl.—Palatine.
Vo.—Vomer.
Ps.—Presphenoid.
Bs.—Basisphenoid.
Bo.—Basioccipital.
p. As.—Pterygoid wing of alisphenoid.
Pt.—Pterygoid.
Sq.—Squamosal.
Ex. o.—Exoccipital.
pg.—Postglenoid ledge of squamosal.
p. ty.—Posttympanic ledge of squamosal, which with *pg.* forms a secondary external auditory meatus.
Ty.—Tympanic bulla.

FORAMINA, ETC.

ty. p.—Anterior process of tympanic.
tp. h.—Tympanohyal.
eu.—Eustachian opening of tympanic.
a. p. f.—Anterior palatine foramina (canals).
i. o. f.—Infraorbital foramen.
p. n.—Posterior nares.
p. a. s.—Alisphenoid canal.
f. l. m.—Foramen lacerum medius.
f. ov.—Foramen ovale (confluent with *f. l. m.*)
i. c. c.—Canal for internal carotid artery.
f. st. m.—Stylomastoid foramen.
f. l. p.—Foramen lacerum posterius.
c. f.—Notch, a vestige of condylar foramen (?) (confluent with *f. l. p.*).

TEETH.

$i.^2$—Tusk.
p^3 (*dm*2).—Third premolar (or second deciduous molar of authors).
p^4 (*dm* 3).—Fourth premolar (or third deciduous molar of authors).

the grinders and their alveolar pouch, have had a marked effect on the relations of the bones and foramina of the sphenoidal region: the obliquely placed external portion of the orbito sphenoid (Fig. 2); has been squeezed into a long,

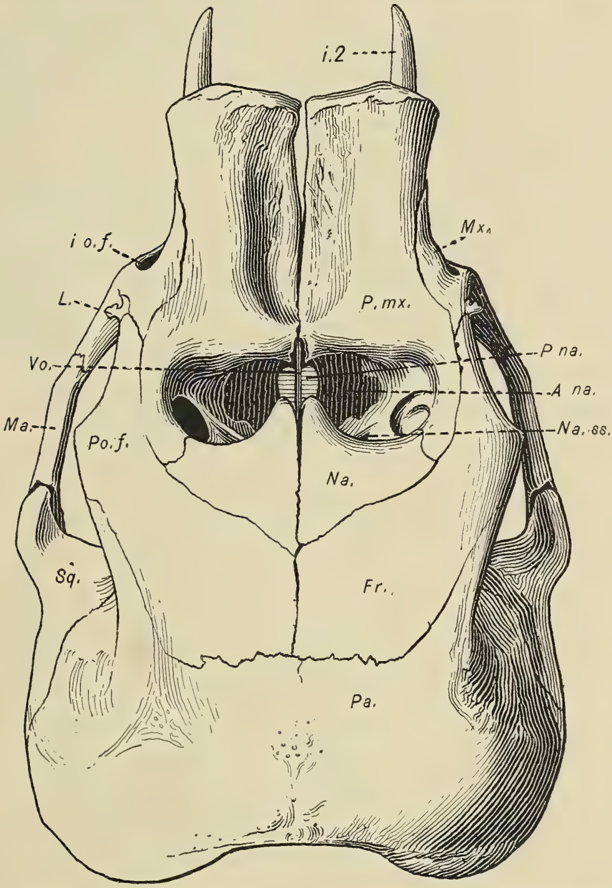


Fig. 2. Superior view of the same skull. From Osborn. Abbreviations as above; also *La.*—Lachrymal. *A. na.*—Anterior nares. *Na. s.*—Narial sinus.

thin process; internally (Pl. XXIII) the anterior edges of the basisphenoid are directed outward and backward; both internally and externally the optic foramen, foramen lacerum anterius, and foramen rotundum, in the order named, are

obliquely arranged on descending levels from within outward and from in front backward, the whole region having been thickened by the separation of the inner and outer tabulæ of

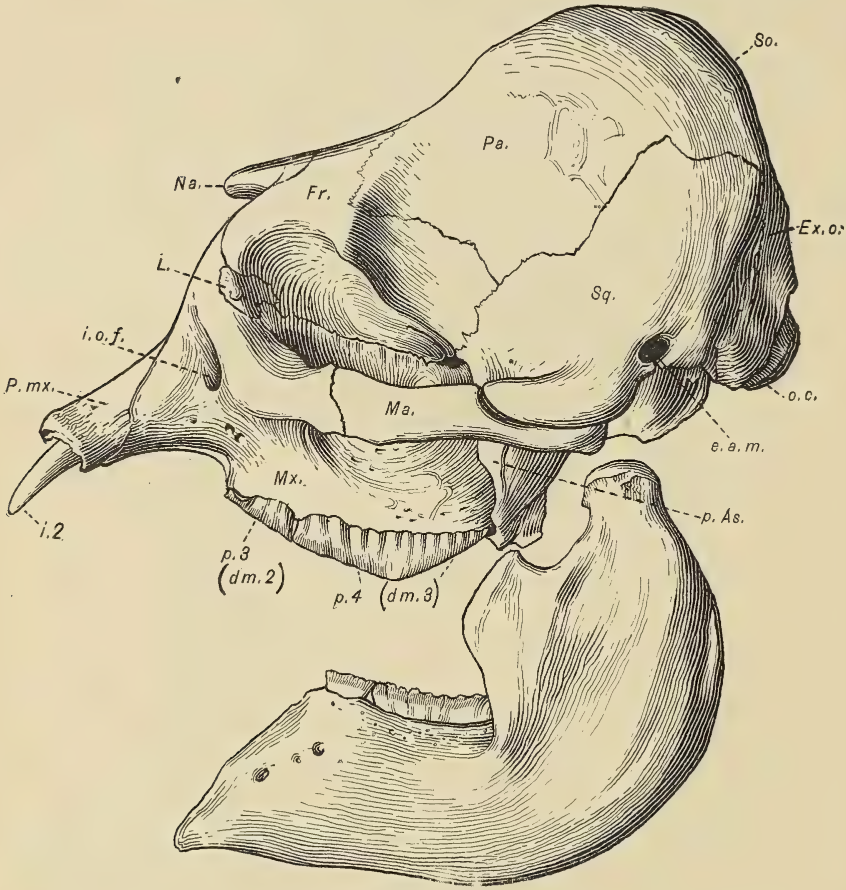


Fig. 3. Side view. From Osborn.

all the bones, and also sharing in the upward-and-backward tilting of the nasal region and in the general fore-and-aft squeezing of the skull, the end result being that the foramina have been pulled out into long tunnels running obliquely for-

ward, outward, and downward; especially internally the fore-and-aft extent of the alisphenoid proper is brief.

Internally the skull has shortened up, one might almost say in bellows fashion, with the optic foramen on each side at the apex of the internal transverse folding (Pl. XXIII), the ridge of the "lesser wing" of the human sphenoid. As the skull has also expanded transversely, the general effect of the internal view of the skull is thus that of compression around the

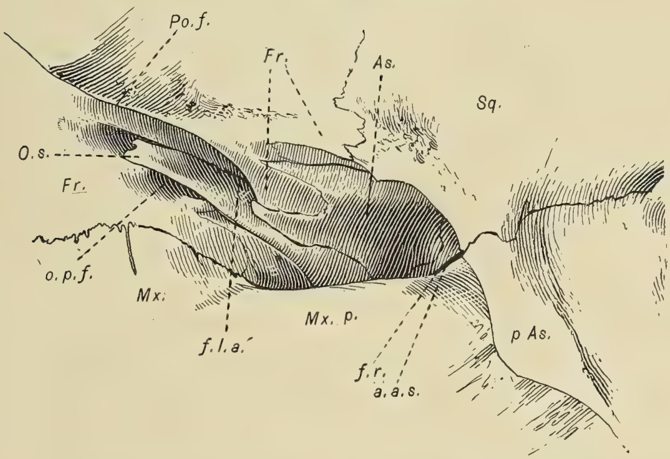


Fig. 4. Orbito-sphenoidal region, left side. From Osborn. The view is obliquely from the side and from below the malar bone (compare Fig. 3).

BONES.

Po. f.—Post-orbital ridge of frontal.
Fr.—Frontal.
O. s.—External process of orbitosphenoid.
As.—Alisphenoid.
Sq.—Squamosal.
p. As.—Pterygoid wing of alisphenoid.
Mx. p.—Maxillary pouch for molars.

FORAMINA, ETC.

op. f.—Foramen opticum.
f. l. a.—Foramen lacerum anterius.
f. r. and *a. a. s.*—Arcade leading to foramen rotundum and anterior opening of the alisphenoid canal.

center (represented by the basisphenoid) and increasing expansion toward the periphery — somewhat recalling the conditions of the domelike human skull. Between the frontal and temporo-sphenoidal fossæ, which form a large trefoil as seen from above, there is on each side, running obliquely outward, forward, and upward, a prominent triangular buttress, the transverse ridge mentioned above, to the formation of which the orbitosphenoid, frontal, and parietal contribute. On each

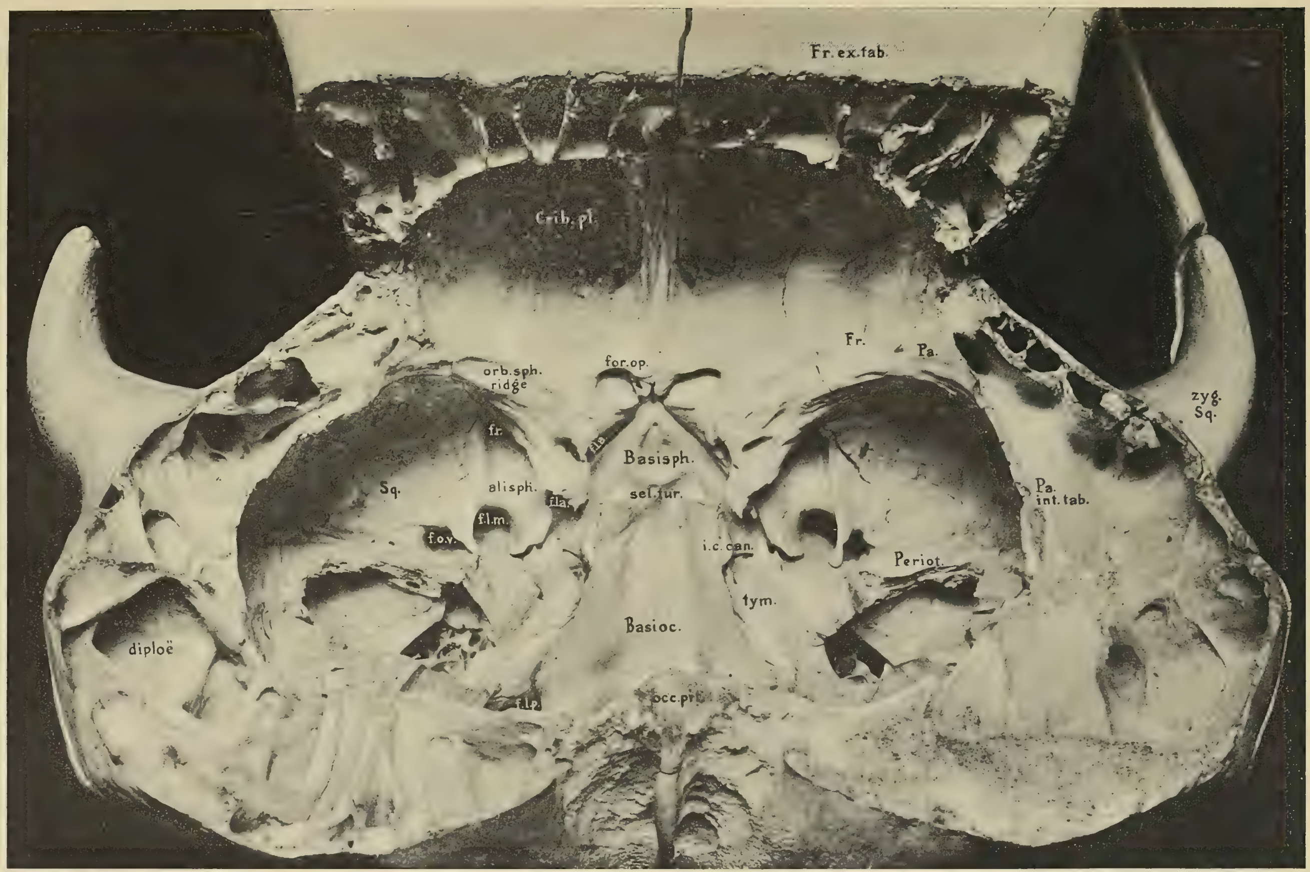
side, at a point opposite the malars, where the skull is most constricted laterally, these buttresses branch off externally into symmetrically opposed arches in different planes, which pass forward, backward, downward, or upward. The wedge-shaped basisphenoid, situated between the inner ends of the buttresses, is the veritable keystone of this converging system.

The skull as a whole is thus highly adapted to resist the severe strains put upon it. The occiput, both in ontogeny and phylogeny, flattens out and rotates backward, spreading both vertically and laterally, until at last it forms, as it were, a great, functionally solid bed-plate, receiving the thrusts of the opposite inverted arches into which the skull has been resolved. Each pair of these symmetrically disposed arches, which also connect with the system culminating in the basisphenoid, reacts, of course, against some component of the force transmitted either to or from the tusks, trunk, and grinders, or when the forehead is used in pushing. The innumerable toughly constructed air cells of the diploë give immense strength, lightness and especially resiliency. This desideratum may also be the reason for the very loose articulation of the malar with the zygomatic process of the squamosal, which would also permit the facial portion of the skull to bend back slightly, under pressure, toward the cranial portion.

EXPLANATION OF PLATE XXIII.

Interior view of the skull of a young Asiatic elephant. From a forthcoming memoir by Professor Osborn.

Crib. pl.	= cribriform plate.
Fr. ex. tab.	= external tabula of frontal.
Fr.	= frontal.
Pa.	= parietal.
Pa. int. tab.	= internal tabula of parietal.
Zyg. Sq.	= zygomatic process of squamosal.
Periot.	= broken edge of periotic.
tym.	= tympanic.
Basisph.	= basisphenoid.
Sel. tur.	= sella turcica.
Basioc.	= basioccipital.
occ. pit.	= occipital pit for ligamentum nuchæ.
Alisph.	= alisphenoid.
orb. sph. ridge	= orbitosphenoidal ridge.
for. op.	= foramen opticum.
f. l. a.	= foramen lacerum anterius.
f. r.	= foramen rotundum.
f. l. m.	= foramen lacerum medius.
f. ov.	= foramen ovale.
i. c. can.	= opening of internal carotid canal.
f. l. p.	= foramen lacerum posterius.



INTERIOR VIEW OF SKULL OF YOUNG ASIATIC ELEPHANT.

Article X.—ON A COLLECTION OF UPPER CRETACEOUS FISHES FROM MOUNT LEBANON, SYRIA, WITH DESCRIPTIONS OF FOUR NEW GENERA AND NINETEEN NEW SPECIES.[1]

Plates XXIV–XXXVII.

By O. P. Hay.

In accordance with an arrangement entered into between Professor H. F. Osborn, Curator of the Department of Vertebrate Palæontology, and Professor R. P. Whitfield, Curator of the Department of Geology, the writer has studied the collection of fishes which was made in 1901 by Professor Alfred Ely Day in the Cretaceous deposits of Mount Lebanon, Syria. This collection consists of several hundred specimens of fishes, besides a considerable number of crustaceans and a few mollusks. The result of the examination of the fishes has been the discovery of a considerable number of undescribed species and various additions to our knowledge of the structure of species already described. A large part of the collection and nearly all of the new species come from a village called Hajula. This may be regarded as really a new locality, since I have been able to find it mentioned only once in Dr. A. S. Woodward's Catalogue of the Fossil Fishes in the British Museum. From a letter written by Professor Day to Professor Whitfield we learn that Hajula and Hakel are each about twelve miles nearly northeast of the seacoast town of Jebeil, the ancient Biblus. Hajula is situated six miles south of Hakel; and between the two villages there are two westwardly projecting spurs of Mount Lebanon and an intervening valley. Professor Day estimates the elevation of these villages to be

[1] The collection of fossil fishes, of which the new forms hereinafter described form a part, was made by members of the staff of instructors of the Syrian Protestant College at Beirut, Syria, during the year 1901, and donated to the American Museum of Natural History by the Rev. D. Stuart Dodge. They now form a part of the Museum's exhibit in the Geological Hall as part of its chronological series, under the head of the Cretaceous formation, in the foreign series of fossil forms.

As Dr. O. P. Hay has recently been engaged in preparing a catalogue of the fossil fishes of the Museum collection and is familiar with the forms found at the Syrian localities, it has been considered advisable to place this collection in his hands for identification. While doing this he has found several interesting species not hitherto known to science. These are described and illustrated in the following pages as a contribution to the work of this department.— R. P. Whitfield, *Curator of the Department.*

between 2500 and 3000 feet. In both places there are clear evidences of faulting by which the fish-bearing strata have been let down into the midst of older strata. Those at Hakel have been let down to the level of the hippurite limestone of Lebanon, being above the Trigonia sandstone. Professor Day thinks that the Hajula beds are an extension of those at Hakel. This study of the fishes appears to show that the horizon of the beds at Hajula is some what higher than that of the beds at Hakel. Professor Day says that one notable difference is found in the great abundance of crustaceans at Hajula.

According to Professor Day, the fish-bearing strata at Hakel are exposed over a space of half an acre or more on the side of a valley, which slopes about 30° to the northeast, the dip of the strata corresponding nearly with the slope. The outcrop at Hajula is similar, but more broken up and irregular. At both localities the slabs of rock which lie on the surface are more easily and perfectly split than are those which are dug up from some depth.

Professor Day was not permitted to work at Sahel Alma.

Much credit is due to the Rev. D. Stuart Dodge, at whose suggestion and expense this collection was made, and to Professor Day, who has displayed great industry and good judgment in gathering the materials.

At the close of this paper the writer will add a few words on the age of the strata.

In the following pages most of the specimens are recorded under two numbers, of which the second is enclosed within parentheses. The first number is the one given to the specimen in the Department of Geology, while the number in parentheses is the one which it bears in the general catalogue of fishes. This catalogue belongs to the Department of Vertebrate Palæontology.

Figure 2, Plate XXVI; figures 3 and 4, Plate XXXVI; and figures 4–6, Plate XXXVII, have been reproduced from photographs made by Mr. A. E. Anderson. Figures 3 and 4, Plate XXVI, are from drawings made by Mrs. L. M. Sterling. All the other figures are from photographs made by Mr. Rudolph Weber.

Class ELASMOBRANCHII.

LAMNIDÆ.

Otodus sulcatus *Geinitz.*

PLATE XXVI, FIGURES 3 AND 4.

Otodus sulcatus GEINITZ (H. B.), Char. Schicht. u. Petrefakt. sächs.-böhm. Kreidegeb., Nachtr., 1843, p. 5, pl. iv, fig. 2.

Lamna sulcata WOODWARD (A. S.), Cat. Foss. Fishes, I, 1889, p. 398. (Synonomy and literature.)

In the collection there is a single tooth of a shark, and this I refer to the above species. The number of the tooth is 4508 (3867).

The height of the crown has been about 15 mm., but the apex is broken off. The crown has resembled that of a specimen figured by Geinitz in 1875 (Palæontogr., XX, pt. 1, pl. lxv, fig. 4*d*). At the base of the crown, in front, the width is 6.25 mm. At the base, the anterior face is somewhat concave, but it soon becomes slightly convex. There are a few short grooves at the base of the crown in front. The cutting edges are very sharp. The posterior face is very convex, and there are present numerous sharp costæ of various lengths. The lateral denticles are relatively large, close to 5 mm. high, and are costate both in front and behind, although the anterior costæ are feeble.

The root is relatively large, and its branches make a very acute angle with each other. The outer borders descend from the lateral denticles so as to be nearly parallel with each other. In this respect the root resembles that of Sauvage's *Odontaspis rochebrunei* (Bull. Soc. géol. France [3], VIII, p. 437, pl. xiii, fig. 3). The tooth from Hakel differs from the one just referred to in having a less slender crown and more prominent lateral denticles. The length of one branch of the root is 10 mm.; of the other, 12 mm.

Collected at Hakel.

PRISTIDÆ.

Sclerorhynchus *Woodward.*

PLATE XXIV, FIGURE 1.

WOODWARD (A. S.), Cat. Foss. Fishes, I, 1889, p. 76.

In the collection there is found the greater portion of the trunk of a sawfish, No. 4502 (3686). To what species this may belong cannot now be determined. The shagreen granules of this trunk are small, and are furnished with two or three longitudinal ridges and intervening furrows. In two of the species of this genus here described, *S. sentus* and *S. hiram*, no shagreen is satisfactorily observable behind the rostrum, while in *S. solomonis* the shagreen appears to be wholly smooth. Hence, while it is improbable that the trunk belongs to the latter-mentioned species, it cannot be connected with either of the others. The shagreen of the trunk resembles that of *Pristis perrotteti.*

The structure of the species of *Sclerorhynchus* here described, especially the evidence that the gill-slits opened on the lower side of the head, shows that the genus is to be referred to the Pristidæ.

To whatever species this trunk may belong, it gives us a clear idea of the form of the body of the Upper Cretaceous sawfishes. And this form is remarkably like that of *Pristis*. As is to be observed from the figure (Pl. XXIV, Fig. 1), the body is long and slender. The portion at hand begins apparently near the base of the pectoral fin and ceases about the root of the caudal fin. The length of the part is 280 mm. It is not certain that any portion of the pectoral fin is seen. The depth of the body anteriorly is 47 mm. Both the dorsal fins and one ventral are presented. All are triangular in form and approximately of the same length. The base of the first dorsal is 36 mm.; the height, 21 mm. The apparent height of the ventral fin is 14 mm. At the base of each fin are seen impressions of the cartilaginous supports of the fin. At the base of the first dorsal there are at least 16 rays; at the base of the second dorsal, a somewhat greater number; at the base of the anal, at least a dozen.

The vertebræ have been well calcified. In front of the first dorsal there are present 24 vertebræ; from the front of the first dorsal to the front of the second dorsal, 34; behind the latter, 20. The diameter of those beneath the first dorsal fin is 5 mm.

In the abdomen of the specimen just described, is seen the skull and most of the vertebral column of a bony fish, probably *Eurypholis boissieri* (Pl. XXIV, Fig. 1).

It is interesting to observe how closely the sawfishes of the Upper Cretaceous resemble those of our own day in most of their characters, and yet how primitive is the condition of their rostral teeth. We cannot doubt that our modern species of *Pristis* have descended from forms closely like those found at Mount Lebanon.

No species known to belong to *Pristis* has, I believe, yet been found in Cretaceous strata. In my work, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' page 316, I have credited *Pristis curvidens* Leidy to the Cretaceous of New Jersey; but on examining the matter more closely, I have concluded that the deposits from which Leidy's specimens were derived belong really to the Eocene.

Sclerorhynchus solomonis, sp. nov.

PLATE XXV.

The specimen on which this species is based, No. 4503 (3706), consists of the rostrum complete or nearly so, the head somewhat damaged, and a faint impression of one pectoral fin. It is the upper surface of the head which is directed toward the observer. The plate will impart a sufficiently clear idea of the form and proportions of the parts.

Dr. A. S. Woodward has described and figured the type of the genus *Sclerorhynchus*, *S. atavus* (Cat. Foss. Fishes, I, 1889, p. 76, pl. iii, fig. 1). The only part which this author had at his command was a portion of the rostrum, with the teeth along its borders. That the present species is distinct from *S. atavus* is evident from various considerations.

The tip of the rostrum is slightly damaged, so that there is

some doubt regarding a small patch of scales seen there. Measuring from the mouth to this patch of scales, which appear to form the tip, the distance is 150 mm. The borders of the rostrum have been straight or slightly convex. At 50 mm. in front of the mouth the width of the rostrum is 50 mm.; at a distance of 100 mm. the width equals 35 mm. Beyond this the rostrum appears to have narrowed somewhat more rapidly. A glance at the rostrum described by Dr. Woodward shows that it was of a different form, the lateral borders being concave. In *S. solomonis*, at a point 45 mm. in advance of the mouth, the head begins to expand rapidly, so that at a line slightly in front of the mouth the width is 100 mm. In *S. atavus* the width in a corresponding position could not have been more than 75 mm.

The preservation of the rostrum is due to its being composed of a mosaic of minute hexagonal calcifications, such as we find in the same cartilages of *Pristis*. If there was a shagreen overlying these cartilages, it does not now show itself. A stellate shagreen is present along the sides of the head as far forward as where these join the rostrum. Over the base of the fin rays the shagreen scales are polygonal, convex, smooth, and enameled.

The rostral teeth of this species are quite different from those of *S. atavus*, in size at least. The longest of those represented in Dr. Woodward's figure are 7 mm. long, and there are about 4 of them in a distance of 10 mm. In *S. solomonis* there are no teeth more than 3 mm. long, and there are 8 of them in 10 mm. These teeth have a stellate base, as in *S. atavus*, and they appear to have been directed somewhat backward. For some distance beyond the base, for one third or one half of its length, the tooth is terete; then the diameter is suddenly increased, forming a sort of shoulder. The remainder of the tooth is gently curved backward, slightly flattened, and brought to an edge on the convex border. It is apparently only the distal portion of the tooth which is enameled. Toward the extremity of the rostrum the teeth are somewhat smaller. Posteriorly, the teeth become very small and are hardly to be distinguished from some of the

shagreen scales on the border. Some of these scales are also stellate.

There are some indications of gill arches and of the base of the pectoral fin, but they are not distinct enough for description. On the right side is seen the outline of the mouth, and a few small teeth appear.

This specimen was collected at Hajula.

Named in honor of Solomon, king, philosopher, poet, and naturalist. "And he spake of trees from the cedar that is in Lebanon even unto the hyssop that springeth out of the wall; he spake also of beasts and of fowl and of creeping things and of fishes."

Sclerorhynchus hiram, sp. nov.

Plate XXVI, Figure 1.

The type of this species consists of the head, with probably most of the rostrum, the pectoral fins, and the anterior portion of the vertebral column. Its number is 4501 (3705), and it was collected at Hajula.

The extremity of the rostrum is missing. The portion present extends 103 mm. in front of the mouth. The form of the rostrum corresponds quite accurately to that of *S. atavus*. From the latter species *S. hiram* is to be distinguished principally by the size and structure of the teeth of the rostrum. Those of *S. atavus* reach a length, according to Dr. Woodward's figure (Cat. Foss. Fishes, I, 1889, pl. iii, fig. 1), of 7 mm.; and there are not more than 4 of them in a length of 10 mm. In *S. hiram* they are not more than 3 mm. long, and about 8 of them are found in a distance of 10 mm.

In *S. atavus* each rostral tooth is said to comprise "a high, round base, crimped, and having a somewhat stellate appearance when viewed from beneath; upon this is fixed a backwardly directed crown, compressed to an anterior and posterior edge." In *S. hiram* each enameled crown is fixed on a high, round base, but this base is not crimped, but perfectly smooth, and no evidences have been observed of any stellate appearance. Each crown is curved, but, in addition to this,

the crown as a whole is directed backward so as to make an angle of 45° with the axis of the pedicel produced. As in *S. atavus*, the crown is flattened to anterior and posterior edges. As in *S. atavus*, again, the teeth appear to graduate posteriorly into the dermal scales; but this occurs at a greater distance in front of the mouth than in the species from Sahel Alma.

At 50 mm. in front of the mouth the rostrum is 46 mm. wide; at a distance of 100 mm., 35 mm. wide; at the mouth, 75 mm. wide. The rostral cartilages have been well developed and have left their impress on the matrix. These and all the other cartilages present a mosaic of hexagonal calcifications. From the point where these cartilages begin to narrow, in front of the mouth, a band of stellate shagreen runs backward along the sides of the head. In a few other places the shagreen appears to have been circular in form and smooth. The mouth resembles that of the living species of *Pristis*, and it has a width of 50 mm. The teeth are small, and some of them appear to have been furnished with one or more sharp ridges, one of which was doubtless the cutting edge.

The position of the gill arches is seen in the figure. On the outer borders of each are seen the rays which supported the gill septa. There can be no doubt that the gill slits opened out on the lower side of the body, and that hence the genus belongs to the Pristidæ.

This species is dedicated to Hiram, king of Tyre, the friend of Solomon, who furnished for the latter cedar-trees and fir-trees from the forests of Lebanon.

Sclerorhynchus sentus, sp. nov.

Plate XXVII, Figure 1.

The only portion of this fish that is known is a part of the rostrum. This fragment, numbered 4504 (3864), has a total length of 153 mm. The distal end of this rostrum is missing. The proximal end of the specimen is supposed to have come close to the mouth. From the distal end, where the width is 29 mm., the specimen expands gradually until, at a distance of 80 mm. from the distal end, the width has become 45 mm.

From this point backward the width again diminishes until at the proximal end the width is about 35 mm. It might be supposed that immediately behind the widest part of the rostral cartilages the shagreened skin would part from the cartilages and pass outward and backward to the sides of the head. There is, however, no indication of such expansion of the head, and a few teeth are found at a little distance behind this broadest part of the rostrum.

The rostral teeth resemble most those of *S. solomonis*, but they are still smaller, not exceeding 2.5 mm. in length, and numbering 10 in 10 mm. The base does not appear to be distinctly stellate. From *S. hiram* the teeth differ in that the enameled blade does not form any considerable angle with the pedicel.

The form of the rostrum is quite different from that of *S. solomonis*, in that it does not contract so rapidly toward the distal end, and it has evidently been longer in proportion to its width. The rostrum has been composed of small, hexagonal, smooth calcifications. Most of these are now removed from the fossil, only their imprints remaining. A peculiar feature, one not found in either *S. hiram* or *S. solomonis*, is the presence of two rows of denticles throughout about the anterior two-thirds of the fragment, one row on each side of the midline. These denticles appear to have had a height of about a millimeter. Only their bases are seen, the remainder being buried in the matrix. The bases are stellate on their hinder borders, but not in front. The denticles are placed about 3 mm. apart. Whether they were on the upper or the lower side of the rostrum I am unable to determine. These doubtless belonged to the shagreen, and they appear to be all of the dermal structures, except the teeth, that now remain.

It will, perhaps, be profitable to note certain differences in the forms of the rostra of the three species described in this paper. In *S. hiram* the rostral cartilages have a width, where widest, of 44 mm., and the mouth is placed 55 mm. behind this. In *S. solomonis* the greatest width is 55 mm., and the mouth is only 40 mm. behind this widest portion. In *S. sentus* the rostrum has a maximum width of 45 mm., and the

mouth must have been at least 75 mm. behind this. As will be observed from the figures, the rostrum of *S. solomonis* tapers toward the distal end more rapidly than that of either of the two other species.

Locality, Hajula.

RHINOBATIDÆ.

Rhinobatus eretes, sp. nov.

PLATE XXIV, FIGURE 2.

The type and only known specimen of this species was collected at Hajula. It has the number 4500 (3715). As may be seen from the figure, Pl. XXIV, Fig. 2, the specimen is quite incomplete, neither the extremity of rostrum nor the tail being present. The species has probably resembled *R. tenuirostris* Davis in having had a much-prolonged snout, but this is uncertain. There appear, however, to be characters which are sufficient to distinguish the present form from the Sahel Alma species just mentioned.

In general, the type has about the same size as the type of *R. tenuirostris*. The distance from the pectoral arch to the mouth is the same in the two; the distance between the inner borders of the hinder lobes of the pectoral fins is a little greater in *R. eretes*. The differences noted between the two species are the following:

The concavity of the sides of the head opposite the gill arches is considerably greater in *R. eretes* than in *R. tenuirostris*. In the latter the pectoral fin extends forward to a point somewhat in front of the mouth; in *R. eretes* it lacks about 25 mm. of reaching a point opposite the mouth. In the type of *R. tenuirostris* the pectoral measures, fore and aft, 180 mm.; in *R. eretes* they measure 103 mm. It is thus seen that the latter species has a much shorter fin in proportion to the size of the animal.

It is evident that the ventral fins are also relatively smaller than in *R. tenuirostris*. In the latter the length of this fin along the body is 75 mm.; in *R. eretes* the hinder extremity of this fin is broken away, but the whole length could not have been more than 60 mm. The anterior border of the ven-

tral of *R. eretes* is about 30 mm. and the breadth 20 mm., as compared with 50 mm. and 25 mm. respectively in *R. tenuirostris*.

We cannot be certain what was the form of the apex of the pectoral fin of the species here described, since, after taking into account the remnants of the right and the left fins, there yet remains about 30 mm. of the border unrepresented, and this includes the apex.

The mouth of *R. tenuirostris* appears to have been smaller than that of *R. eretes*, the former being said to measure about 33 mm. from side to side, while the latter measures 40 mm. In the mouth of *R. eretes* there are seen several rows of teeth. They each measure a millimeter in length parallel with the jaw, and each has a thin cutting edge, in the middle of which is a conical point.

The vertebræ have a diameter of about 7 mm. Davis states that those of *R. tenuirostris* have a diameter of 0.1 inch, but this is obviously an error. The length of those of *R. eretes* is 2.6 mm.; and, according to this, there would be about 15 of them between the pectoral and the pelvic girdles. Davis states that those of *R. tenuirostris* have a length of .15 inch, and that there are 14 of them between the two girdles.

Over the greater portion of the body of the specimen here described the shagreen has been removed. There is, however, a band of stellate scales along the margin of the rostrum; and further toward the midline, apparently on the upper side of the rostrum, there are three or four rows of similar scales. Along the greater part of the border of the front lobe of the pectoral fin the shagreen has become smooth, and each scale nearly circular in form. Probably this represents the general character of the shagreen.

RAJIDÆ.

Raja whitfieldi, sp. nov.

Plate XXVIII.

This new species is represented in the collection by three specimens, No. 4505*a* (3707), No. 4505*b* (3708), and No.

4505*c* (3709), all from Hajula. Of these the first-named is taken as the type, inasmuch as it presents a greater portion of the body than either of the others does. Even in this, the tail is missing and a part of the right side is gone.

The disk is broad and rounded. The snout is slightly drawn out, but its tip is rounded. The greatest width across the pectorals is 156 mm. The distance from the snout to the hinder border of the pectoral girdle equals 82 mm.; from the snout to the pelvic girdle, 117 mm. There appear to be 15 vertebræ between the pectoral and pelvic girdles.

The disk is everywhere covered with a very fine shagreen, and no asperities are anywhere visible. On the upper surface of the snout there are a few enlarged scales, each nearly 2 mm. across. On the upper surface, on each side of the midline and over the pectoral girdle, is a patch of scales, some of which are about .5 mm. in diameter.

On each side of the head, where the scales have been broken away so as to expose the mouth, may be seen a few small teeth. The impressions of the gill arches are faintly seen; likewise those of the eyes and the nasal cavities.

The other specimens add little or nothing to our knowledge of the species.

Three other species of *Raja* have been described from Mount Lebanon. *Raja expansa* (Davis), from Hakel, has a very broad disk, and the pectoral fins are acute at their outer angles. This species was regarded by Davis as belonging to *Rhinobatus* (Trans. Roy. Dublin Soc., (2), III, 1887, p. 486, pl. xviii). *Raja primarmata* A. S. Woodward (Cat. Foss. Fishes, I, 1889, p. 85, pl. iv, figs. 1–3), from Sahel Alma, also has the outer angles of the pectorals acute. *Raja minor* Davis (*op. cit.*, p. 493, pl. xxi, fig. 2), from Sahel Alma, is either a very small species or the young of a species otherwise unknown. The pectorals are rounded. There is little or no shagreen on the disk. The disk is very broad.

This species is named in honor of Professor R. P. Whitfield, Curator of the Department of Geology of this Museum, who is the author of many important memoirs on palæontology, among them one entitled 'Observations on some

Cretaceous Fossils from the Beyrut District, Syria, in the Collection of the American Museum of Natural History, with Descriptions of some New Species' (Bull. Amer. Mus. Nat. Hist., III, 1891, pp. 381–441, pls. iv*a*–x).

Class PISCES.

BELONORHYNCHIDÆ?

Stenoprotome, gen. nov.

The writer finds it difficult to determine with any certainty either the relationships or the characters of this genus. The following characters are given provisionally:

Body furnished with large tuberculated bony scutes. Vertebral centra not developed. Head elongated, the snout slender, obtuse at the apex. Teeth of moderate size, conical. Opercular? bone furnished with a long, curved spine. Type, *Stenoprotome hamata* sp. nov. Derivation of name, στενός, narrow, and προτομή, the face.

Stenoprotome hamata, sp. nov.

Plate XXVI, Figure 2; Plate XXVII, Figure 2.

The specimen which forms the basis of the following description was obtained at Hakel, and the number is 4509 (3863). The head is the part most satisfactorily preserved, and figures are here presented of both the counterparts. The most striking feature of the fish is the possession of two long, curved, spines, one on each side of the head. Each of these ends in a sharp point; and just proximad of the point is a sharp barb. The distal end of the spine resembles closely the point of a fishhook. The writer has not been able to determine conclusively what bone supports this spine. On looking at *Coccodus* it is suggested to one that the spine is homologous with the lateral spine of that genus, but further consideration makes it evident that the present form has no relationships with the pycnodonts; and the close attachment of the spine to the side of the head and its evident great extension forward indicates that it is rather the opercular bone.

The length of the head, from the apex of the snout to a line joining the hinder borders of the lateral spines, is 35 mm. The apex of the snout is rounded and only 3.5 mm. wide. The skull lies with the upper surface toward the viewer. The bones are so closely united that their limits cannot be distinguished. The surface is almost everywhere covered with tubercles, sometimes scattered, but usually arranged in rows more or less regular. A few of those on the upper surface of the snout form short spines.

Along the borders of the snout, for about 20 mm., there are seen, at intervals of two or three millimeters, what appear to be teeth, but which are possibly only enlarged marginal tubercles. Between the larger ones are others of smaller size. Some medium-sized ones are found at the apex of the snout. At a considerable distance behind the head is seen a stout bone bearing four or five teeth larger than those of the rostrum, the largest about 1.5 mm. in length. This bone seems to the writer to be a portion of the lower jaw, which has been displaced.

As may be seen from Pl. XXVI, Fig. 2, *orb.*, there are, between the bases of the spines, two rings of bone. These appear to be the sclerotic rings and to indicate the position of the eyes; but, incomprehensibly enough, these have been overlain by some bones of the upper surface of the skull. The appearances of the fossil are not consistent with the supposition that the lower surface of the head is presented. There is probably some distortion here.

Behind the bases of the spines the fossil contracts for about 10 mm. Whether this region belongs to the skull or not is not easily decided. There appear to be five bones here, an elongated median one, extending the full length of the area, and two others on each side. Of the latter, the hindermost sends an arm forward along the outside of the more anterior one. These bones can be distinguished on the specimens only by close inspection.

Behind the area mentioned, at *a*, Pl. XXVII, Fig. 2, there is a bony mass whose surface is covered with ridges which converge to a point at one side. These ridges may repre-

sent either the sculpture of a bony scute or a number of rays of a dorsal fin. On one side of this, *b*, is a bony scute whose axis runs obliquely to the axis of the head; while at *c* there is another scute whose greater axis is transverse to that of the head. Still farther away, at *d*, is found the supposed lower jaw. Around this are some remains apparently of fin rays. Finally, at *e*, is seen a very large bony plate, 33 mm. long and 21 mm. wide. One end is narrowed and rounded off. Near this plate also there are seen scattered fin rays. All the plates are tuberculated.

Nowhere are there any certain evidences of vertebral centra or ribs. There seem to be some evidences of neural or hæmal arches.

PYCNODONTIDÆ.

Coccodus lindstrœmi *Davis.*

Plate XXIX, Figure 1.

Coccodus lindstrœmi Davis (J. W.), Jour. Geol. Soc., XLVI, 1890, p. 565, pl. xxii.—Woodward (A. S.), Cat. Foss. Fishes, III, 1895, p. 268.

Of this not well-known species there are in the collection three specimens. One of these, No. 4517*a* (3698), with its counterpart, presents the head. The second, No. 4517*b* (3699), much damaged, shows a part of the head, with the occipital spine, and a portion of the abdominal region. The third, No. 4517*c* (3793), also presents the head and a complete occipital spine. The first-mentioned specimen is here figured (Pl. xxix, Fig. 1). On the hinder border of the spine there are 14 denticles. The region below the orbit has been covered with bony plates, whose surface was ornamented with more numerous and smaller tubercles than the other portions of the head. Behind the occipital spine is seen a series of fin rays, 10 in number. They are slender, and present distinct evidences of segmentation, but none of longitudinal division. They extend downward beneath the bony covering of the region and toward the neural spines, or between them. No. 4517*c* (3793) shows the presence of the

same rays, and here they seem to be longitudinally divided. They appear to form a feeble anterior dorsal fin.

Through a fracturing of the snout some of the teeth, apparently those of the splenial bone, are exposed. The rows cannot be counted, but the teeth themselves are very much smaller than those of *Coccodus armatus*. At the tip of the lower jaw is seen a small, conical, pointed tooth.

The specimens are from Hakel.

Coccodus insignis, sp. nov.

Plate XXIX, Figures 2–5.

Of this species there are in the collection several specimens, all from Hajula. The following six are especially to be mentioned: Nos. 4516*a* (3666), 4516*b* (3700), 4516*c* (3701), 4516*d* (3702), 4516*e* (3703), and 4516*f* (3794). Of these, No. No. 4516*b* (3700) and No. 4516*d* (3702) are to be regarded as the types. The former consists of a somewhat damaged fish which has been flattened from above downward, and may be taken as showing the form of the fish when seen from above. Only the tip of the tail fin is missing. The total length is 80 mm. On each side is seen a broad, hooked spine, a part of the shoulder girdle. The head is pointed in front, and it and the anterior body region expand backward to the ends of the spines mentioned, so as to be wedge-shaped. These lateral spines appear to be much broader than the corresponding ones of *C. armatus*, as figured by Davis (Trans. Roy. Dublin Soc., III, pl. xxx, fig. 1) and Woodward (Cat. Foss. Fishes, III, p. 267). The anterior, or outer, border of each is finely denticulated. The upper and lower surfaces are ornamented with fine ridges, which start from the base and converge to the point. Anteriorly these ridges become tuberculated. In front and behind, the base of each spine passes into anterior and posterior processes of the pectoral arch. Lying in the curve of the hinder border of the pectoral spine and on the matrix from which a portion of the spine has been removed are seen abundant remains of pectoral fin rays; but these have been much disturbed. The rays of the dorsal are so

much disturbed that their number cannot be determined; but they are not numerous. Somewhat in front of a perpendicular from the origin of the dorsal fin are seen the ventral fins and their supports. The latter are 6 mm. long and rather slender. So far as can be determined, there are only 5 fin rays in each, and the outermost of these is short and claw-like. The divided rays are also segmented. The anal fin is disturbed, and the caudal is missing. Another specimen, No. 4516*f* (3794) (Pl. XXIX, Fig. 2 *v. f.*), appears to have an additional divided ray in the ventral fin.

In No. 4516*b* (3700) two or three rows of teeth can be seen. Nothing more can be said of them than that they resemble those of *C. armatus*. There are indications given by the neural and hæmal arches that there were 15 or more vertebral segments.

The block bearing this specimen has been broken along the length of the fish in such a manner as to expose the occipital spine, which was buried in the matrix. This is represented by Fig. 3 on Pl. XXIX. It is readily seen to be different from that of either *C. lindstrœmi* or *C. armatus*, being broad antero-posteriorly and relatively short. The posterior edge is finely denticulated; the anterior edge is nearly smooth. The lateral surfaces are ornamented with fine ridges, which rise from the base and either terminate in the borders or ascend to the apex. Just behind this spine there is another process of bone which may be either another spine or a ridge passing across the rear of the skull. Its hinder border overhangs the anterior vertebræ.

The co-type, No. 4516*d* (3702) (Pl. XXIX, Fig. 4), is a small fish having a length of 97 mm. from the snout to the end of the caudal fin. The specimen is especially interesting because it presents the shoulder girdle from below. It is difficult to determine what sutures exist in this region. The lower ends of the right and left halves of the girdle join in the midline, and here the bones are 8 mm. wide, fore and aft. The suture between them is very distinct for a part of the distance across the bridge, but it then becomes indistinct. Whether or not these bones are separated by suture from the bases of the

lateral spines I have been unable to determine with any certainty; but they are possibly distinct bones.

Dorsal and anal fins are present, but their rays are disturbed.

What are probably vomerine teeth are presented. There are three rows on one side of the midline and one row on the other, and there were not less than 5 rows. Those of one of the rows farther from the midline are compressed laterally and each forms a longitudinal cutting edge. The other teeth have a part of their triturating surface mammillated and the borders finely crenulated.

No. 4516*e* (3703) is a fish which has been spread out either by crushing or by inflation by gases during decomposition. The space occupied by the notochord is enlarged so that the bases of the neural arches and those of the ribs are from 6 to 11 mm. apart. This specimen shows that both the neural arches and the hæmal arches had their proximal ends expanded against the notochord. The expansions of the neural arches join and form a continuous covering for the upper side of the notochord. The ends of the hæmal arches probably did not come into contact with each other or with the neural arches.

Beneath the dorsal rays I count 10 interneural supports. There appear to have been 8 anal rays. There are traces of both pectoral and ventral fins. In one gill chamber are seen the impressions of four series of gill filaments.

No. 4516*a* (3666) shows the fish as seen from the side, and thus gives us an idea of the elevation of the head and body. The total length is 120 mm. The height of the body at the pectoral spine is 30 mm. Only a faint impression of the occipital spine remains. The rays of the dorsal fin cannot be counted. The lower rays of the caudal are the longest and the fin ends rather bluntly. The anal appears to comprise 8 rays. The ventrals are distinctly displayed. There is a continuous line of bones along the upper side of the notochordal region, the bases of the neural arches. Eleven neural arches are counted from the middle of the back to the base of the caudal fin. Vomerine and splenial teeth are seen, but the number of rows cannot be determined.

No. 4516*c* (3701) lacks the hinder portion of the body (Pl. XXIX, Fig. 5). The fish presents the body as seen from above, but damaged somewhat, the roof of the skull being gone, as well as the occipital spine. The head is 40 mm. long, from the snout to a transverse septum formed apparently by the shoulder girdle. Splenial teeth are present, three rows on each splenial. Six teeth are found in each row, and there were probably three or four more. The ones in front are small. The inferior transverse portion of the shoulder girdle is seen, on the left side, passing across beneath remains of probably gill arches. Faint indications of pectoral fin rays are seen on one side.

No. 4516*f* (3794) appears to deserve description and illustration (Pl. XXIX, Fig. 2). The inferior surface of the body lies toward the viewer, and the apex of the occipital spine has been found by excavating on the opposite side of the block. From the base of one pectoral spine to the other, a bar of bone crosses the body. It presents a fractured edge toward the abdominal surface, and has, in all probability, been a ridge, or plate, of bone which extended upward from the inferior transverse portion of the shoulder girdle.

Behind the right (left in the figure) pectoral spine are seen the neural arches with their conjoined expanded proximal ends. Each arch is seen to have a wing-like expansion in front of the spine. Crossing the upper ends of the hindermost spines are seen some interneural supports of the rays of the dorsal fin. Immediately behind the bar of bone, passing from one pectoral spine to the other, are seen some confused ribs. Then come the supports of the ventral fins and the fins themselves, and immediately behind and above these, the expanded ends of the hæmal arches. Behind each pectoral spine are seen the remains of pectoral fin rays. Twelve of these may be counted behind the right spine. The proximal ends of these rays are to be seen on the matrix mesiad of the base of the spine. This proves that the pectoral fins were inserted above the spines.

In front of the transverse bar of bone mentioned above is seen the parasphenoid. In front it appears to receive

between two prongs the hinder end of the vomer. On the latter there appear to have been four rows of teeth, but many of these teeth are broken away.

The counterpart of specimen No. 4516*c* (3701) presents the parasphenoid bone. Posteriorly this seems to join a basisphenoid. On the lower surface of the latter, in the midline, there is a short, pointed, downwardly directed process.

All the specimens were collected at Hajula.

ELOPIDÆ.

Holcolepis attenuatus (*Davis*).

Clupea attenuata Davis (J. W.) Trans., Roy. Dublin Soc. (2), III, 1887, p. 580, pl. xxxiii, fig. 4.

Osmeroides attenuatus Woodward (A. S.), Ann. and Mag. Nat. Hist. (7) II, 1898, p. 409; Cat. Foss. Fishes, IV, 1901, p. 19.

No. 4526 (3781), from Hakel, is a specimen which the writer is unable to distinguish from Davis's *Clupea attenuata*, a species hitherto known only from Sahel Alma. In the present specimen the total length is 95 mm.; to the base of the caudal fin, 77 mm. The head, including the opercular apparatus, is about 23 mm., but the extremity of the snout is missing. The depth is only 15 mm. There are a few more than 50 vertebræ, of which not more than 20 belong to the caudal region. There are 20 interneurals supporting the dorsal fin. Davis reports the presence of only 10 rays in the dorsal, but this is doubtless an error. This fin, in our specimen, is equally distant from the occiput and the base of the caudal fin. The ventrals are inserted below the front of the dorsal. The anal is disturbed, but there are 7 supporting interhæmals present. It is entirely behind the dorsal. The bones of the head are smooth. Nothing can be determined regarding the size or the form of the scales.

There are various reasons for not identifying this specimen as *H. sardinioides* (Pictet). It is entirely too slender to be *H. lewisi* (Davis). The dorsal and ventral fins of the latter are farther backward, and there are said to be 35 vertebræ in the abdominal region behind the operculum.

Dr. A. S. Woodward has called our attention to the fact that the name *Holcolepis* antedates *Osmeroides* as a name for the species of this genus (Cat. Foss. Fishes, IV, p. 11).

ICHTHYODECTIDÆ.

Eubiodectes, gen. nov.

Teeth in sockets? Vertebræ with lateral grooves; the centra pierced by the notochord. Some of the anterior pectoral rays expanded distally, and longitudinally divided. Anal fin elongated, falcate in front. Type, *Chirocentrites libanicus* Pictet and Humbert. Derivation of name, εὐβιος, *well-living;* and δήκτης, *a biter.*

Eubiodectes libanicus, (Pict. and Humb.).

Plate XXX, Figure 1.

Chirocentrites libanicus Pictet and Humbert, Nouv. Rech. Poiss. Foss. Mt. Liban, 1866, p. 88, pl. xiii.—Davis (J. W.), Trans. Roy. Dublin Soc. (2), III, 1887, p. 585.

Ichthyodectes libanicus Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 105.

This species has been referred by Dr. Woodward to the genus *Ichthyodectes.* However, a comparison with *I. anaides*, the type of *Ichthyodectes*, will convince one that the Syrian species belongs elsewhere. In *I. anaides* the anterior pectoral ray is very stout, but it does not expand distally; and I know of no evidence that its distal end was split into fine filaments. It formed rather a sort of spine, like that of *Portheus.* The succeeding rays were considerably smaller than the anterior one and were distally divided, as is usually the case with such rays. In *I. anaides* the notochord seems not to have passed continuously through the centrum of the vertebra; but in the Syrian species under consideration there was free communication between the concave ends of the centrum. In this Syrian species the anal fin is very long; we have no proof that it was so in the American species of *Ichthyodectes.* For these reasons I place the *Chirocentrites libanicus* of Pictet and Humbert in a distinct genus. I have not seen the teeth,

nor have I found any statement that they are lodged in sockets. If they are not in sockets, this will furnish another character to distinguish the species from *Ichthyodectes*.

In the collection there are several portions of this fish, but no complete specimen. None of these furnish the teeth. One example, No. 4506*a* (3681), shows the fish from apparently just behind the pectoral girdle to the base of the caudal fin. This length is 400 mm. In this distance there are about 54 vertebræ, but these have been disturbed anteriorly. The depth at the origin of the anal fin is 120 mm. The anal fin begins 186 mm. in front of the base of the caudal. There are apparently about 8 strong rays in front; behind these the rays are weak and, in the fossil, form an obscure fringe along the body. There are altogether 34 interhæmal fin supports. The whole length of the anal base is 137 mm.

So far as indicated by the specimen, the dorsal fin begins 110 mm. in front of the base of the caudal fin and opposite the beginning of the hinder third of the anal. Only 10 rays can be counted, but there may have been others posteriorly. Large interneurals are present in front of the fin, but there seem to have been no rays attached to them. The neural and hæmal spines are long, slender, and sigmoid in form. The vertebræ both of the abdominal and caudal regions are somewhat higher than long, about 7 mm. long and 9 mm. high. The side of the centrum is excavated by a pair of rather deep pits or grooves. Where the centra happen to be split longitudinally they show that the notochordal perforation is a millimeter or more in diameter.

About 95 mm. in front of the dorsal fin, and therefore not far behind the head, there is, on the back, a rounded mass of bone. This seems to be connected with the distal ends of some rather stout interneurals. This mass is about 27 mm. long, 10 mm. high, and 5 mm. thick from side to side.

Most of the scales are removed from the fossil. They appear to have been about 15 mm. high, and their exposed portion about 8 mm. fore and aft.

Another specimen, from Hajula, No. 4506*b* (3646), confirms the above description, except that it does not include

the region of the bony mass behind the head. There are apparently 13 dorsal rays. A considerable portion of the body is covered with scales. No. 4506*c* (3799), from Hakel, exposes on the matrix an impression of the caudal fin. It has been deeply forked. The larger rays have been obliquely segmented; the median ones split up into smaller filaments.

No. 4506*d* (3866) is part of a fish which had a depth of at least 125 mm. It presents the ventral fins; but no other fins are present to afford us a means of locating the position of the ventrals. These fins appear to have been about 30 mm. long.

No. 4506*e* (3823), from Hakel, is about as large as No. 4506*a* (3681). It seems to present some traces of the ventrals at a point 75 mm. in front of the anal fin. There are also some faint indications of the bony mass on the back, to which reference has been made above.

No. 3899, of the Cope Collection, is probably from Hakel. The specimen resembles much the one figured by Pictet and Humbert, but not so much of the body is present. One pectoral fin is well exposed, mostly as an impression on the matrix (Pl. xxx, Fig. 1). The longest ray, the most anterior, has a length of 65 mm., and its distal end is slightly more than 7 mm. wide. The next ray, somewhat shorter, is 9 mm. wide distally. The other rays are successively shorter and narrower. All the rays, for a great part of their distal portions, are longitudinally divided. There appear to be somewhat more than 10 rays. No teeth are seen in this specimen.

CTENOTHRISSIDÆ.

Ctenothrissa signifer, sp. nov.

PLATE XXXI, FIGURES 1 AND 2.

Two fishes which were collected at Hajula belong evidently to an undescribed species of *Ctenothrissa*. The number of the type is 4521*a* (3651). With its counterpart, it furnished all parts of the animal. A second specimen is numbered 4521*b* (3813).

The total length of the type is 80 mm.; to the base of the caudal fin, 55 mm. The body is deeper than it is in *C. vexillifer* (Pictet), the greatest depth, 30 mm., being contained in the length to the base of the caudal somewhat less than two times; and in the distance from the pectoral arch to the base of the caudal, one and one fourth times. The length of the head, 21 mm., is less than the greatest depth of the body.

The height of the dorsal fin is fully 30 mm., and when depressed its distal end would reach beyond the base of the caudal fin. It contains 20 rays, including the anterior undivided ones. The anal fin has a height of 13 mm., but the rays are broken and zigzagged, so that it is evident that originally the fin was still higher. There are present in it 13 or 14 rays.

The body is slightly turned, so that both ventral fins come into view. These sweep backward along the lower border of the body and cross all the anal fin-rays. The pectoral fins are only dimly seen.

The maxilla is provided with short conical teeth. This bone and the supramaxilla resemble those of *C. radians*, as figured by Dr. A. S. Woodward (Cat. Foss. Fishes, IV, pl. x, figs. 2, 3). The cheeks and the opercular bones are covered with scales.

No. 4521*b* (3813) shows only the posterior half of the body. The dorsal fin is depressed and overlaps the base of the caudal fin. The anal rays pass somewhat behind the last caudal vertebra. Some of the rays of the ventrals extend beyond the origin of the anal.

This species differs from *C. vexillifer* in having a shorter and deeper body, much higher dorsal and anal fins, and longer ventral fins.

No. 4522 (3802) is a small fish from Hakel which I identify as *C. vexillifer.* The length to the base of the caudal is 35 mm. and the depth is 14 mm. The fish is therefore considerably slenderer than the specimens of *C. signifer.* The pectoral fin in this Hakel specimen also is long, as in those from Hajula; but the dorsal is not more elevated than usual.

DERCETIDÆ.

Leptotrachelus serpentinus, sp. nov.

PLATE XXXII, FIGURE 1.

This species is represented in the collection by two specimens, No. 4511*a* (3683), which was collected at Hajula, and No. 4511*b* (3739), which was obtained at Hakel. The first mentioned specimen is regarded as the type. It lacks a large part of the caudal region and the whole of the head, except a part of the opercular apparatus. The length of the specimen in its present condition is 260 mm., and the total length in life could hardly have been less than 300 mm., and was probably more. The distance from the opercular region to the ventral fins is 134 mm. The diameter (probably the horizontal) at the ventral fins is contained in the distance from the operculum to these fins thirteen times. In *L. triqueter* the diameter at the ventral fins, as shown by Pictet and Humbert's figure (Nouv. Rech., pl. xiv, fig. 1), is contained in the part of the body in front of the ventral fins about seven times. We have in both of these cases apparently the breadth of the body and not its height. *L. serpentinus*, therefore, appears to have been a much slenderer fish than *L. triqueter.* This slenderness is shown also by the bodies of the vertebræ, which are more than three times as long as the diameters of their articular ends. In *L. triqueter* the bodies are said to be twice as long as deep.

There are 31 vertebræ between the operculum and the ventral fins, about the same number as in *L. triqueter.* The vertebral centra are much constricted. Each vertebra of the abdominal region sends out on each side two long processes, which diverge from the middle of the centrum. The broader one is directed outward and forward. Near its end there is articulated to it the head of a long, slender rib. The posterior and narrower process is directed outward and backward. Its distal end approaches very closely the rib-bearing process of the next vertebra behind. In the region of the ventral fins these processes are nearly 5 mm. long. These lateral processes are found on about 12 of the vertebræ behind the ven-

tral fins. The posterior process appears to be the one first reduced, but both soon disappear. From the figures and descriptions of *L. triqueter* we must conclude that there is only a single process on each side of each centrum.

There are present about 6 or 7 rays of one pectoral fin, and these are about 15 mm. long. A broad bone having a posteriorly directed process lies just behind the operculum. This may belong to the pectoral arch. The dorsal fin is missing, unless it is represented by two or three rays which lie above the ventral fins.

One of the ventral fins is present and appears to contain 6 rays. Its supporting bone is 7 mm. long and 2.5 mm. wide posteriorly, and is pointed in front. No remains of the anal fin are seen.

As may be seen from the figure, on the upper side and behind the ventral fin, there is a row of triradiate dermal scutes running along one side of the body. A similar row is found on the other side, but the bone is broken away and only the imprints of the scutes are left on the matrix. These scutes continue for some distance in front of the ventral fins. They appear to have a longer anterior branch than do those of *L. triqueter.* There are also numerous fine intermuscular bones throughout the length of the fish.

The condition of the vertebræ and dermal scutes occupying some distance behind the head is not easy to determine, on account of the presence there of the bodies of three small fishes. It is possible that these had been swallowed, but their presence there is more probably accidental.

The specimen collected at Hakel is a fragment 98 mm. long. It is from the portion of the body behind the ventral fins. It presents no new features.

From *Leptotrachelus gracilis* Davis (Trans. Roy. Dublin Soc., III, 1887, p. 623, pl. xxxviii, fig. 3), this species differs in having a much less slender anterior abdominal region and probably a longer post-pelvic region. Davis's species likewise had quite different lateral vertebral processes.

Collected at Hajula and Hakel.

ENCHODONTIDÆ.

Enchodus marchesettii ? (*Kramberger*).

PLATE XXX, FIGURES 2 AND 3.

Eurygnathus marchesettii KRAMBERGER (D. G.), Djela Jugoslav. Akad., XVI, 1895, p. 34, pl. vii, fig. 2.

In the collection are two specimens of an *Enchodus* which seems to be distinct from *E. longidens;* and, since there are no species of fishes known to be common to Sahel Alma, where the latter species is found, and Hakel, where *E. marchesetti* was found, it appears to be best for the present to retain the two species as distinct. It is proper to state that I have had no specimens of *E. longidens* for direct comparison, and I have not been able to see Kramberger's description and figure of his species. The present identification is therefore wholly provisional.

The two specimens are numbered respectively 4507*a* (3779) and 4507*b* (3859). The former (Pl. xxx, Fig. 2) presents the head, except a portion of the lower jaw, and the body to the rear of the anal fin, except a portion of the back. No. 4507*b* (3859) consists of the body and tail from the beginning of the dorsal fin. The two specimens have been almost identical in size, and they supplement each other quite completely.

The head of No. 4507*a* (3779) is 55 mm. long to the hinder border of the operculum. The lower jaw has been broken away just below the tooth-line, leaving the teeth, but rendering it impossible to determine the depth of the jaw. The teeth have been slender, some of them quite long; and they are furnished with a few sharp grooves, especially distally. The premaxilla has been of moderate size, and furnished with a long, now missing, fang. The skull and opercular bones appear to have been ornamented as in *E. longidens*.

In front of the dorsal fin are three dermal scutes. These are of an elongated oval form, with pointed ends. The anterior and largest is 8 mm. long and a little more than 3 mm. wide. From the centre of each, ridges radiate to the circumference. Below each scute there is seen a plate of bone which

appears to be an expansion of an interneural bone. This has probably formed a support for the scute. The first interneural support of the dorsal fin is similarly expanded. Along the position of the lateral line is seen a succession of small thin scutes, each not more than 2 mm. long. These are to be observed as far backward as the rear of the dorsal fin, where they lie close to the upper border of the vertebræ. It is probable that they continue to the base of the caudal. I have observed no traces of the hooked dermal scutes that are described as occurring at the base of the tail of some species.

The pectoral fin has had a length of at least 25 mm., and it must have had somewhat more than 15 rays. The ventrals arise about 30 mm. behind the pectorals and slightly behind the origin of the dorsal fin. Its rays are somewhat damaged in both specimens, but they were at least 17 mm. long. The number of dorsal fin rays cannot be accurately determined, since some are wanting in both specimens; but there were probably 16, as in *E. longidens.* The anal fin was supported by 19 rays, so that the fin does not appear to have differed from that of *E. longidens.* The caudal fin is deeply forked, and some of the external rays are rather strongly developed.

In the specimen showing the head there are 24 vertebræ in front of the origin of the dorsal fin, and 15 behind this point; therefore 39 altogether, possibly 40. Dr. A. S. Woodward, in his description of *Enchodus longidens* (Cat. Foss. Fishes, IV, p. 199), states that there are 24 vertebræ in the caudal region of the latter species. In our specimens from Hakel, the twenty-fourth vertebra from the base of the caudal fin will be on a line joining the base of the ventral fins with the anterior portion of the dorsal. Not more than 19 or 20 vertebræ can be fairly assigned to the caudal region. This may furnish us with one difference between *E. longidens* and *E. marchesettii.* Another will probably be found in the different forms of the dorsal scutes, those of *E. longidens* being broadly oval, those of our Hakel specimens elongated oval.

Besides the specimens described above, there are in the collection three others which probably belong to the same species. One of these, No. 4527*a* (3735), is from Hakel; the

others, No. 4527*b* (3840) and No. 4527*c* (3832), are from Hajula. The first-mentioned presents the head and the body to behind the ventral fins; the two others, only the heads. In the first, the lower jaw has a width of 11 mm. and a length of 45 mm. The teeth behind the anterior fangs appear to be compressed to edges and to be striated and grooved. The fangs are slender. No dorsal scutes are present. In No. 4527*c* (3832), the jaw is 12 mm. wide and apparently 55 mm. long. The teeth, upper and lower, are mostly damaged, but they are rather coarsely striated; and many of them, even the large fangs, are furnished with edges.

No. 4527*b* (3840) and its counterpart furnish the head of a large individual. The length of the head to the hinder border of the operculum is 120 mm. The length of the lower jaw is 80 mm.; its depth is 21 mm. The head has been crushed from above. Both tumid palatines are shown, each with a long slender fang. The fang is nearly smooth on the outer side, but coarsely striated on the inner side. Whether cutting edges are present is not certain. The lower fang is likewise striated on the inner surface. This belongs possibly to a different species, but this cannot now be demonstrated.

Specimens from both Hakel and Hajula.

MYCTOPHIDÆ.

Osmeroides *Agassiz.*

Osmeroides Agassiz (L.), Poiss. Foss., V, pt. ii, 1844, p. 103.—Pictet (F. J.), Poiss. Foss. Mt. Liban, 1850, p. 27.

Sardinioides Marck (W. v.), Zeitschr. deutsch. geol. Gesellsch., X, 1858, p. 245.—Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 236; Foss. Fishes English Chalk, 1902, p. 32.

Dermoptychius Marck (W. v.), Palæontogr., XV, 1868, p. 287.

The employment of the name *Sardinioides* for this genus is an evident violation of the law of priority; a law recognized by all naturalists, but obeyed with reluctance by many when their prepossessions are attacked; and the only means now provided for deciding between rival systematic names. The type of the genus is *O. monasteri* Agassiz.

The species which are satisfactorily determined as belonging to the genus are the following: *Osmeroides monasteri* Agassiz, *O. crassicaudus* (Marck), *O. megapterus* Pictet, *O. pusillus* (A. S. Woodward), *O. woodwardi*, nom. nov. (= *Sardinioides attenuatus* A. S. Woodward), *O. macrophthalmus* (Marck), and the two new species below described, *O. pontivagus* and *O. ornatus*.

Three other species of doubtful value, according to Dr. A. S. Woodward, have been described by von der Marck, *O. macropterygius*, *O. minutus*, and *O. tenuicaudus*.

Osmeroides pontivagus, sp. nov.

PLATE XXXIII, FIGURES 1–4.

This species is represented by at least 15 individuals. The size is small, and the fish is closely related to *O. pusillus*, which has been described as *Sardinioides pusillus* by Dr. A. S. Woodward from Sahel Alma (Cat. Foss. Fishes, IV, p. 240, pl. xvi, figs. 2, 3). *O. pontivagus* differs from the latter in several important respects. Dr. Woodward states that in *O. pusillus* the serrations of the scales are deep and conspicuous. In *O. pontivagus*, on the contrary, they are very obscure, and it is only in favorable situations on the matrix, and with the aid of a good lens, that they can be seen at all. There are also more rays in the dorsal fin than there are in the species from Sahel Alma, 12 or 13, instead of 10 or 11. There are quite certainly 9 rays in the anal fin. The ventrals are inserted somewhat behind the origin of the dorsal fin, and they show the presence of 7 rays. Several specimens present at least 13 rays in the pectoral.

The mouth of this species is large, the articulation of the lower jaw being placed well behind the orbit. No. 4524*b* (3846) has the mouth widely opened and shows the slender and toothed premaxilla as forming the whole of the upper border of the mouth (Pl. XXXIII, Fig. 1). There is a patch of teeth on the palatopterygoid arch. The maxilla is expanded at the distal end. There were probably 8 branchiostegal rays on each side. There are about 30 vertebræ, not more.

No. 4524*a* (3845) (Pl. XXXIII, Fig. 2), is taken as the type of this species. It has a length of 60 mm.; to the base of the caudal, of 47 mm. The head is 16 mm. long, and the depth is 20 mm.

Among the specimens which I am compelled to refer to this species there is much variation in the depth of the body. On Pl. XXXIII, Figs. 1, 2, are represented two specimens which have very deep bodies. Fig. 3 of the same plate shows another specimen, No. 4524*c* (3855), whose body has less depth. In this, the depth of the body, 15 mm., equals the length of the head. The distance from the snout to the base of the caudal fin is 50 mm. No structural differences are to be seen. Still slenderer specimens occur, as No. 4524*e* (3852), which is 37 mm. long from the snout to the base of the caudal fin, while the depth is only 10 mm. Between the extremes there are all gradations in relative depth.

In some of the slenderer specimens there is a tendency toward a deepening of the fins. In No. 4524*f* (3841) (Pl. XXXIII, Fig. 4), about 50 mm. long to the base of the caudal and 15 mm. deep, the rays of the dorsal fin extend backward two thirds of the distance from the fin to the base of the caudal. The anal is rather deep, while the pectoral rays fully reach the base of the ventrals, and the rays of the latter lack but little of attaining the front of the anal. In No. 4524*g* (3842) from Hakel, the dorsal and anal fin-rays extend backward to the base of the caudal.

In some, but not all, of the slender individuals, the scales appear to be quite thick; but this condition may be due to some peculiarity of preservation.

The slender specimens described here resemble somewhat *O. woodwardi* (= *Sardinioides attenuatus*), described by Dr. A. S. Woodward, from Hakel (Cat. Foss. Fishes, IV, p. 241, pl. xii, fig. 5). However, the latter is a more elongated fish, having the length of the head contained in the distance between the pectoral arch and the base of the caudal fin three times. It also has the scales conspicuously serrated, and only 10 or 11 rays in the dorsal fin.

All of the specimens, except two, are from Hajula.

Osmeroides ornatus, sp. nov.

Plate XXXIII, Figure 5.

No. 4518 (3870), from Hakel, appears to belong to an undescribed species of *Osmeroides.* Only a single specimen has been found in the collection. The total length is 48 mm.; to the base of the caudal 36 mm. The length of the head, including the opercular apparatus, equals 14 mm. The greatest depth is 12.5 mm. It will be seen, therefore, that the depth is less than the length of the head, and is contained in the distance from the pectoral arch to the base of the caudal fin less than twice. There are 25 vertebræ behind the operculum; hence not more than 30 altogether. There are 11 or 12 in the caudal region. The dorsal fin arises 7.5 mm. behind the occiput. The number of its rays is uncertain, but there are probably not more than 10. The ventrals are inserted below the anterior half of the dorsal. The rays of the anal cannot be counted, but the fin is short. The caudal is deeply forked. The pectoral fins are delicate and inserted well above the ventral border.

The scales are thick and deeply serrated, as may be seen on the matrix, and even in some places where the scales overlie one another. The operculum is conspicuously ornamented with coarse ridges and rows of tubercles, which radiate from the articulation of the bone with the hyomandibular. There seem to be similar ridges on the other opercular bones and apparently on the cheeks.

The mouth appears to have been relatively small, the articulation of the lower jaw being advanced to a perpendicular line from the front of the orbit. The lower jaw is only 5 mm. long. The orbit is rather large.

This species differs from *O. megapterus*, a Sahel Alma species, in having fewer vertebræ, 30 or fewer instead of 40. From *O. woodwardi* Hay (= *S. attenuatus* A. S. Woodward), from Hakel, it differs in being less elongated and in having coarsely serrated scales. It appears to resemble most *O. pusillus*, described as *Sardinioides pusillus* by Dr. Woodward, from Sahel Alma, but the latter is a more robust species, with

evidently a larger mouth. Nothing in the description indicates that its opercular bones are ornamented like those of *O. ornatus*.

Collected at Hakel.

Acrognathus *Agassiz.*

Acrognathus Agassiz (L.), Poiss. Foss., V, pt. ii, 1844, p. 108.—Woodward (A. S.), Cat. Foss. Fishes, IV, 1901, p. 243; Foss. Fishes English Chalk, 1902, p. 36.

The type of this genus is *A. boops* Agassiz. The type specimen of this species is practically the only known example. It is refigured in Dr. Woodward's publication of 1902, cited above. Unfortunately this author has not figured his *A. libanicus*, from the Cretaceous of Sahel Alma. The following species is believed to be congeneric with the one described from Sahel Alma, but it is doubtful if either belongs to the genus *Acrognathus*.

Acrognathus dodgei, sp. nov.

Plate XXXIV, Figure 3.

The type of this species is No. 4520*a* (3673). It has a total length of 88 mm.; to the base of the caudal fin 68 mm. The head and the opercular region together measure 20 mm. The depth is 21 mm. The rays of the dorsal fin are somewhat confused, but there appear to be 12 interneural supports. The pectoral fin is wanting in the specimen. The ventrals are slightly in front of the origin of the dorsal, but this is probably due to slight displacement. The rays are stout. The anal is somewhat damaged, but it was evidently short. The vertebræ number 32 or 33. The scales are thick.

The premaxilla is furnished with small teeth. The mandible is high posteriorly. Its length is 10 mm. The articulation is brought forward to beneath the eye.

At the base of the caudal fin, both above and below, are about half a dozen reduced rays, and these are preceded by a very short, but stout, modified ray, which appears to have

been pointed at both ends. It resembles a similar ray seen in the same situation in *Microcœlia dayi.*

Another example, No. 4520*b* (3696), shows the ventrals placed slightly farther backward than in the type. The pectoral fin has 10 rays. Other specimens, referred to the same species, present the pectoral fin as placed considerably above the ventral border.

It is probable that normally the ventral fins of this species are inserted opposite the middle of the dorsal fin.

This species differs from *A. boops* Agassiz and *A. libanicus* A. S. Woodward in having a shorter head and a smaller orbit. All the specimens, about 10 in number, are from Hajula, except No. 4520*c* (3836), No. 4520*d* (3767), No. 4520*e* (3730), which are from Hakel.

Named in honor of Rev. D. Stuart Dodge, the donor of the collection here described.

Nematonotus longispinus (*Davis*).

PLATE XXXIV, FIGURE 2; PLATE XXXV.

Pseudoberyx longispina DAVIS (J. W.), Trans. Roy. Dublin Soc. (2), III, 1887, p. 511, pl. xxv, fig. 2.

Nematonotus bottæ (in part) WOODWARD (A. S.), Cat. Foss. Fishes, IV, 1901, p. 250.

Among the fishes collected by Professor Day at Hajula there is a considerable number which appear to me to be different from *Nematonotus bottæ*, and which I have no means of distinguishing from the species described by Davis, as above cited. The latter has been identified by Dr. A. S. Woodward as *N. bottæ;* and his procedure may prove to be correct. If so, the form here described will require a new specific name.

These Hajula specimens differ from *N. bottæ* especially in the great length of one of the anterior dorsal fin-rays. It also appears to attain a much greater size than does the species from Hakel. Six specimens are especially to be mentioned, as follows: Nos. 4510*a–f* (3655, 3663, 3664, 3678, 3679, 3723).

No. 4510*a* (3655) has a total length of 95 mm. The pectorals and ventrals appear to be larger than they are in speci-

mens of *N. bottæ.* The pectoral seems to have had 13 rays. Of these the third is the largest, its breadth being 1 mm, and it is broken off at a distance of 16 mm. from its base. The ventral fin appears to have comprised 8 rays. These are broken off at a distance of 10 mm. from the base, but they have evidently extended much farther. The dorsal probably possessed 12 rays; there are 12 interneurals. Of the rays, the third is greatly elongated, extending nearly to the tip of the caudal fin. In the anal there are 8 or 9 rays. The caudal is deeply forked. There appear to be 28 vertebræ. The scales are large. I count 4 above the lateral line.

No. 4510*b* (3663) has the caudal region and the caudal fin wanting. The total length must have been close to 170 mm. The head is 39 mm., the depth of the body, 47 mm. The elongated dorsal ray is only 50 mm. long, but had doubtless in life been longer. The pectoral rays are 24 mm. long, but may originally have been longer. The stomach and intestines are represented by their phosphatic contents, the former having formed an S-like loop.

No. 4510*c* (3664) lacks the body in front of the dorsal fin and most of the remainder of the body below the vertebral column. This individual has had a total length of about 200 mm., a giant when compared with the described specimens of *N. bottæ.* From the fork of the caudal fin to the front of the dorsal is 107 mm. The third dorsal ray has no remarkable length, but it appears to have had the extremity broken off.

No. 4510*d* (3678) (Pl. XXXIV, Fig. 2), lacks most of the caudal fin. The specimen measures 70 mm. to the base of the caudal. The third dorsal ray has a length of 56 mm., and would extend nearly to the extremity of the caudal fin. The head is 24 mm. long; the body 37 mm. deep. The longest pectoral ray is nearly as long as the head.

No. 4510*e* (3679) is a nearly complete fish, but it has suffered some weathering. The total length is 102 mm.; to the base of the caudal fin 76 mm. The longest dorsal fin-ray equals 62 mm. No. 4510*f* (3723) (Pl. XXXV), has a total length of 170 mm. The elongated dorsal ray runs to the

edge of the block bearing the fish; the part remaining measures 77 mm., and would have overlapped somewhat the caudal rays.

Other specimens of the genus found at Hajula are referred to *N. bottæ*. Some of these are quite certainly such, but others may belong to *N. longispinus;* being either quite young individuals, or having had the elongated dorsal ray broken off. If the form here called *N. longispinus* is really *N. bottæ*, it appears strange that more individuals have not been found at Hakel, Davis's specimen being the only one found there possessing a greatly elongated dorsal.

Microcœlia dayi, sp. nov.

Plate XXXI, Figure 3; Plate XXXIV, Figure 1.

There is in the collection a considerable number of specimens of what must be regarded as a distinct species of the genus *Microcœlia*. Of these, No. 4525*a* (3692) is taken as the type (Pl. xxxiv, Fig. 1). The total length of this is 98 mm.; to the base of the caudal fin 75 mm. All portions of the body are represented, although in places the scales are flaked off, leaving only their imprint on the fine matrix. The length of the head, including the opercular apparatus equals 23 mm. The depth of the body, greatest between the pectoral and the ventral fins, is 28 mm.; but other specimens seem to indicate that this is not natural. From the shoulder girdle to the base of the caudal fin is 53 mm. There are 42 vertebræ behind the pectoral arch, of which 24 belong to the caudal region. Altogether there are 49 vertebræ. Each vertebral centrum is strengthened by about 5 longitudinal ridges on each side. The jaws are tightly closed, so that the teeth cannot be observed. The gape is evidently large and considerably oblique, the length of the lower jaw being 15 mm. The orbit is large; the diameter of the eye, as shown by the sclerotic bones, is 7 mm. There are 25 or 26 rays in the dorsal fin, including 5 short, undivided ones in front. I count 22 supporting interneurals. In the anal fin there appear to be

18 or 19 rays, but there are 20 interhæmals present. The middle of the back, from the occiput to the dorsal fin, is occupied by a line of crimpings, such as have been mentioned by Dr. A. S. Woodward in the case of *M. libanicus*. These have the appearance of narrow folds or ridges, which are directed upward and backward, each ending in a point. What the relation of these crimpings is to the median row of scales has not been determined.

The pectoral fins are missing from this specimen. The ventrals are inserted somewhat in front of the origin of the dorsal, but they may have been moved slightly forward through distortion.

Another specimen, No. 4525*b* (3677), is a slenderer fish than the type, but this elongation may not be wholly natural. The head has a length of 19 mm., while the depth is only 16 mm. The length of the head is contained in the total length of the fish 4 times, as in the type. The fin rays agree closely with those of the type. The ventrals are placed beneath the origin of the dorsal. Fifteen rays are counted in the pectorals and 13 in the ventrals. In front of the interneural bones which support the dorsal fin rays there are at least 12 others which have no rays. These have the upper ends expanded and turned somewhat forward. These are seen also in the type of the species. Both specimens show also an enlarged, free, and spine-like ray in the midline above and below and just in front of the first caudal rays. It was wholly, or almost wholly, buried in the flesh. There are on each side at least 9 branchiostegal rays.

No. 4525*c* (3798) is a third specimen of this species. It is nearly complete, and it has a length of 84 mm.; to the base of the caudal of 65 mm. The head is 21 mm. long; the depth is 19 mm. There are 49 vertebræ. The origin of the ventrals is beneath that of the dorsal fin. There are apparently 26 rays in the dorsal, and these are supported by 23 interneurals. The anal fin is supported by 20 interhæmals. The crimped scales in front of the dorsal are seen.

No. 4525*d* (3803) has a length of 110 mm. No. 4525*e* (3816) shows unusually well the crimpings in front of the

dorsal (Pl. XXXI, Fig. 3, *cr. sc.*). These appear to consist of squarish masses whose broad sides are applied to the similar masses in front and behind, while the narrower sides look outward and upward. There seem to be about three or four of such masses for each median scale.

All the specimens are from Hajula. The species is named in honor of Professor Alfred Ely Day, of the Protestant Syrian College at Beirut, who made the collection which is described in this paper.

Rhinellus delicatus, sp. nov.

The type of this species is a small and probably young fish. Its number is 4530 (3661). The total length is only 32 mm.; from the snout to the base of the caudal fin is 26 mm. It is also quite slender, the greatest depth being only 2.5 mm. The head is injured, so that little except the upper and lower jaws remains. The whole head seems to have been 7 mm. long. The jaws are slender and are 4 mm. long, but it is not certain that the extremities are not broken off. No teeth are to be seen. Pectoral, ventral, dorsal, anal, and caudal fins are all present. The pectorals have a length of 4 mm. The ventrals are inserted 4.8 mm. behind the base of the pectorals. The number of the rays cannot be determined. The origin of the dorsal fin is about 2 mm. behind that of the ventrals. The rays are delicate, and those that can be counted are 8 in number, but these probably do not represent the whole number originally present. The anal fin is placed halfway between the dorsal and the caudal fins. The number of its rays cannot be determined. The caudal fin is deeply forked.

There appear to be 43 vertebræ. These, especially the more anterior ones, are somewhat longer than deep. No ribs are seen. Scales are present, but their boundaries are indistinguishable.

This fish differs from others of the genus in having the origin of the dorsal fin much nearer the occiput than to the base of the caudal fin.

This species comes to us from Hajula.

GONORHYNCHIDÆ.

Charitosomus hakelensis (*Davis*).

Spaniodon hakelensis DAVIS (J. W.), Trans. Roy. Dublin Soc., III, 1887, p. 591, pl. xxxiv, fig. 4.

Charitosomus hakelensis WOODWARD (A. S.), Ann. and Mag. Nat. Hist. (7), II, 1898, p. 412; Cat. Foss. Fishes, IV, 1901, p. 274.

Some specimens of this species appear to have the ventral fins situated immediately below the origin of the dorsal. No. 4523*a* (3746) is from Hakel. It is much elongated and very slender, but this form may be due to distortion. The anterior portion of the head is missing. The ventrals are placed just below the origin of the dorsal. No. 4523*b* (3817) has apparently 44 vertebræ, and the ventrals are situated slightly behind the front of the dorsal.

In the Cope collection there is a small lot of fishes from Mount Lebanon. There is no record of the locality, but all the species are those found at Hakel. Among these are two specimens of this species. No. 3895 is a nearly complete fish, only the anal fin and a portion of the caudal being gone. The length to the base of the caudal is 82 mm. The elements of the snout are injured, so that not much information regarding them is to be obtained. Dr. A. S. Woodward's conclusions regarding the small size of the mouth are confirmed. No teeth are observed. In this specimen also the ventral fins are below the front of the dorsal. There are 44 vertebræ. Where the scales are present they form an incrustation whose elements cannot be distinguished. Where they are flaked away from the matrix but little impression is left. There are, however, faint lines which seem to indicate that the scales were of an elongated diamond-shaped form, ending behind in a sharp point. Nothing is seen to suggest the spiny scales of *Gonorhynchus*.

The other specimen, No. 3894, is without the head and the caudal fin. The length from the pectoral arch to the base of the caudal has been more than 100 mm. The ventral fins are placed below the middle of the dorsal. Each ventral fin has plainly 8 rays. There are at least 11 rays in the pectoral

fin. Where the incrustation of scales remains there is seen a number of very distinct narrow, longitudinal, whitish lines along the body. These probably indicate rows of scales. I count about 10 of these lines below the vertebral column, and apparently 5 or 6 above it. Possibly this species was longitudinally striped. No additional information regarding the scales is to be obtained.

ANGUILLIDÆ.

Urenchelys *A. S. Woodward.*

Urenchelys Woodward (A. S.), Ann. Mag. Nat. Hist. (7), V, 1900, p. 322; Cat. Foss. Fishes, IV, 1901, p. 337; Foss. Fishes English Chalk, 1902, p. 30.

Urenchelys germanus, sp. nov.

Plate XXXVI, Figure 1; Plate XXXVII, Figure 7.

There are several specimens of eels from Hajula which are referred to this supposed new species. None of these are complete fishes, more or less of the caudal region being missing in all of them. No. 4515*a* (3654) is regarded as the type (Pl. xxxvi, Fig. 1). Of this individual, perhaps about 25 mm. of the extremity of the tail is gone. The remainder of the animal is well preserved. Anteriorly the head and trunk are viewed from above; from just in front of the anal fin backward the fish lies on its side. This species is closely related to *U. avus*, described by Dr. A. S. Woodward from the Upper Cretaceous of Sahel Alma (Cat. Foss. Fishes, IV, p. 337, pl. xviii, figs. 1, 2), and there are few characters by means of which it may be distinguished. However, it appears that the part of the trunk which lies in front of the anal fin has a greater number of vertebræ, and it is longer in proportion to the length of the head than in *U. avus*. The latter is stated to have about 35 vertebræ in front of the anal, whereas *U. germanus* possesses over 40. This portion of the trunk is also about 5 mm. longer than that of *U. avus* relatively to the length of the head.

For these reasons I regard the Hajula specimens as forming a distinct species.

There is in none of the individuals any trace whatever of the ventral fins, although the fishes must have been enclosed in the matrix without any disturbance of their parts. This is indicated by a brown stain on the matrix, which shows that the outline of the body is unbroken in the region where the ventrals would have been located. It is further evident that they are not specimens of *Anguillavus quadripinnis*, since the head of the latter is longer and more pointed; furthermore, in the specimens referred to *Urenchelys* there are no indications of plates in the region of the lateral line.

The head of the type of *U. germanus* has a length of 24 mm.; the portion of the trunk between the head and the anal fin measures 46 mm., and the part of the caudal region remaining equals 74 mm. Between the occiput and the anal fin I count 43 vertebræ. The neural arches of this region are broken away. Slender ribs project on each side. Behind the origin of the anal fin are 47 vertebræ, making 90 in all. In case the caudal region was more than twice as long as the portion of the trunk in front of the anal, as is the case with *U. avus*, there must have been considerably more than 100 vertebræ in the vertebral column.

The upper surface of the skull closely resembles that of *Anguilla.* Vomer, ethmoid, united frontals, the parietals, and probably the supraoccipital and epiotics can be located, although the sutures cannot always be seen. The opercular apparatus is well developed, showing apparently all the elements found in *Anguilla*, and possessing the peculiarities of the latter genus. The lower jaw is two thirds the length of the cranium. The palatopterygoid bar seems to have the structure seen in *Anguillavus.* Many teeth are seen on both the maxilla and dentary.

Both pectoral fins are well displayed, and each had at least 18 rays. As already stated, there are no evidences of ventral fins. The dorsal fin is seen to come as far forward as the 13th vertebra from the occiput. Just behind the head there are 8 vertebræ in 10 mm.; in the anterior portion of the caudal region there are only 6 in this space. From this and other specimens it is seen that the notochord passed uninter-

ruptedly through the vertebral centra. The neural spines of the caudal region are moderately stout and are smaller at their bases than in the middle of their length. The hæmal spines are slender and tapering, and have long, delicate flesh-bones attached to them.

No. 4515*b* (3762) appears to have only 40 or 41 vertebræ in front of the anal fin. In No. 4515*c* (3695) we have what seem to be the most anterior rays of the dorsal fin, and these are placed over the 12th vertebra behind the occiput. Another specimen confirms this view.

No. 4515*d* (3790), from Hakel, probably belongs to this species, since it is too large to belong to *U. hakelensis*. This presents the vertebral column seen from above. In the case of some of the vertebræ the neural arches have slipped to one side of their centra, so that the upper surfaces of the latter are exposed. The right and left portions of each arch are distinct, never having been co-ossified (Pl. XXXVII, Fig. 7).

No. 4515*e* (3860) presents the head and the trunk to a short distance behind the origin of the anal fin. Here also there are 43 vertebræ in front of the anal. The head is flattened from above, and its hinder portion is broken away. Numerous short blunt teeth are seen on the dentary and the maxilla. There are also traces of vomerine teeth. Eleven branchiostegal rays are counted on one side. They extend far backward and the distal ends of some are curved upward. Both pectoral fins are displayed, and each seems to have possessed at least 20 rays. There are no traces of ventral fins, although the conditions seem favorable for their preservation had they existed.

ANGUILLAVIDÆ, fam. nov.

Apodes with well-developed cleithrum, pectoral arch, pectoral and ventral fins, and a distinct caudal fin. Dorsal and anal fins extended. Palatopterygoid arch developed. Scales rudimentary or absent; in some cases a row of enlarged plates on each side, probably on the lateral lines. Ribs present. One genus, *Anguillavus*.

Anguillavus, gen. nov.

The characters of this genus are included in those of the family. The type of the genus is *Anguillavus quadripinnis.*

Anguillavus quadripinnis, sp. nov.

Plate XXXVI, Figures 2 and 3.

Of this species there is recognized in the collection only a single specimen, No. 4512 (3796), collected at Hajula. This specimen lacks the whole of the caudal region. It is lying on the block with the dorsal surface directed upward. The following dimensions are noted: Length of the head to the occiput, 25 mm.; to the posterior border of the opercular apparatus, 33 mm. Length from the snout to the thirty-eighth vertebra, 90 mm.; height of the body, 14 mm.

The suspensory apparatus of the jaws is extended laterally. Hyomandibular and quadrate are present, and from the distal end of the latter the mandible runs forward and projects somewhat beyond the snout, as in *Anguilla.* Parallel with the premaxillæ on each side are the maxillæ. Starting from the quadrate there runs forward on the left side a very distinct palatopterygoid arch. The pterygoid portion terminates 7 mm. behind the snout. For a great part of its length this portion has a width of only one millimeter, and the width is occupied by two distinct bones. Of these, the inner is regarded as the entopterygoid, the outer, as the ectopterygoid. The anterior ends of these bones lie on the upper surface of the parasphenoid, as do also the corresponding bones of the other side; but this position is probably due to some shifting during decomposition. Immediately in front of these pterygoids there is, on each side, a small, scale-like bone which may be the prefrontal. Outside of these, underlapping the anterior ends of the pterygoids, and extending forward toward the snout, are two delicate bones, one on each side, and these I regard as the palatines. The appearance of these bones indicates that they were already much reduced. There are almost certainly no teeth on the arch thus constituted. A bone resembling a supramaxilla lies above the maxilla.

Behind and mesiad of the palatopterygoid arch are seen the anterior ends of the stout hyoids. Slender branchiostegals appear to be attached to these near their anterior ends. Some of the upper branchiostegals are widened out at their posterior ends and curled upward, but not so conspicuously so as in *Anguilla.* The opercular bones appear to have resembled those of *Anguilla*, but mostly only impressions of these on the matrix remain.

The bones of the roof of the skull have been considerably injured, so that the exact limits of the elements cannot be determined.

Fragments of the cleithrum are present. The pectoral fins are well preserved, and the rays, apparently 16 in number, had a length of nearly 9 mm. The number of the baseosts cannot be determined. There are distinct evidences of the scapula and the coracoid.

Both ventral fins are present, attached to their supporting bones (Pl. XXXVI, Figs, 2, 3, *v. f.*). The latter are only slightly more than 2 mm. long. The extremities of the fin rays are broken off. There appear to have been about 8 rays in each fin. These fins are placed 65 mm. behind the occiput, and were doubtless only a short distance in front of the anal fin. Owing to the position of the fish, the dorsal fin is not displayed.

There are 31 vertebræ preserved, the last of which lies over the ventral fins. The centra are constricted, and 5.5 of them occupy the space of 10 mm. The ribs are slender and rather long, some of them 5.5 mm.

There are evidences of the presence of two rows of bony plates, one on each side of the body. These probably occupy the position of the lateral line. On the right side these are shown as impressions on the matrix, and, beginning just behind the cleithrum, continue as far as the specimen is preserved. On the left side, they may be followed throughout the greater part of the abdominal region, and in several places are represented by thin bony scales. These plates, or scales, are relatively large, six of them being found in 10 mm. No other scales or plates are seen on the body.

Collected at Hajula.

Anguillavus bathshebæ, sp. nov.

Plate XXXVII, Figure 1.

The type of this species is No. 4513*a* (3704), while No. 4513*b* (3685) is regarded as the paratype. The type is from Hakel, the paratype is from Hajula. No. 4513*c* (3868) is a second specimen from Hajula.

The type is a nearly complete fish, wanting only the tip of the snout and the extremities of the rays of the caudal fin (Pl. xxxvii, Fig. 1). The paratype presents the hinder half or more of the body. The total length of the type is 168 mm. Two millimeters may be added for the missing portion of the snout. The whole head would then measure, to the occiput, 12 mm.; to the cleithrum, 19 mm. The dorsal fin has evidently had its origin 13 mm. behind the occiput, since there the first rays are seen, and in front of these a stain on the matrix plainly reveals the outline of the body. The dorsal fin continues backward to near the caudal fin, but is plainly distinct from the latter. The caudal is fan-shaped, rounded at the extremity, and is supported by 5 or 6 hypural bones. These characters are confirmed by the paratype. The anal begins 59 mm. behind the occiput and continues to near the caudal fin. The ventral fins have their origin 50 mm. behind the occiput. In the type only one of these fins is preserved, and an injury to the matrix has removed both the supports of these fins. Another flaking away of the rock occurs just behind the ventral; but these rays cannot belong to a detached portion of the anal, since they have the structure of ventral rays, and not that of anal rays. Moreover, the course of the hinder portion of the intestine is shown by its fossilized contents, and this passes above the rays in question. In the paratype both ventrals are in their normal position and attached to their supports. Each of these fins is about 5 mm. long and is composed of 8 rays.

There are apparently 44 vertebræ in front of the origin of the anal fin and 57 behind its origin. The neural arches are long and low, and each is overlapped in front by the preceding arch. The centra are long, constricted in the middle

of the length, and they are permitted the notochord to pass continuously through them. In the abdominal region there appear to be no neural spines. These are first seen as low and rather broad plates just over the origin of the anal fin. They soon become considerably higher and quite slender, but expanding somewhat toward their distal ends. The hæmal arches are well developed, the spines of many of the anterior ones being expanded at their distal extremities. Only the merest traces of a few ribs are seen in the specimens.

The rays of the dorsal and anal fins are slender, and there are, on an average, two and one third interneurals and interhæmals for each vertebra.

The cleithrum is preserved in its natural position. It is sigmoid in form, and is pointed at both the upper and the lower end. The substance of the pectoral fins is wanting, but there is present what appears to be the imprint of one on the matrix.

So far as preserved, the head resembles that of *Anguilla*. The hinder portion of the lower jaw is present, articulated to the quadrate. It is not certain that any part of the palatopterygoid arch is seen. A strongly developed hyoid arch is present, and to each side are attached at least 15 branchiostegal rays. These are long and slender, some of the uppermost ones being broadened at their hinder ends and turned upward. The opercular bone is probably represented by a flake of bone.

Both the specimens appear to have been enveloped in a fine matrix without any part having been disturbed. The lower outline of the body is distinctly marked by a brown stain. This stain and minute patches of similar stain on the sides of the abdominal region may indicate the existence of scales, but of these there is no other evidence. There are no traces of enlarged scales along the sides of the body, such as are found in *A. quadripinnis*.

This eel resembles rather closely Davis's *Urenchelys hakelensis*, and at first it was regarded as such. A closer study has, however, made it certain that the two are distinct species. In *U. hakelensis* the dorsal fin probably came forward to the

occiput. According to the published figures of *U. hakelensis*, the vertebral centra are higher than long. This is confirmed by the examination of three small specimens in this collection. In *A. bathshebæ*, on the contrary, the centra are longer than high, longer, in fact, than the height of the centrum and the neural arch taken together. The figures of *U. hakelensis* show that the portion of the body in front of the anal fin measures 38 mm., the portion behind this fin to the base of the caudal, 53 mm. In *A. bathshebæ* the two portions of the body are practically equal. Of course, the presence of ventral fins in *A. bathshebæ* and their absence in *U. hakelensis* constitutes the most important difference between the two species; but the other differential characters given may enable us to distinguish specimens when the region of the ventral fins is injured or absent.

Named in honor of Bathsheba, who attained the distinction of being a wife of one great king and poet and the mother of another great king and poet.

ENCHELIIDÆ, fam. nov.

Apodes destitute of cleithrum, of all paired fins, and, so far as known, of all median fins. Opercular apparatus greatly reduced. Vertebral centra apparently diplospondylous. No scales.

Enchelion, gen. nov.

Characters included in those of the family. Type *E. montium.* Derivation, εγχέλειον, a little eel.

Enchelion montium, sp. nov.

Plate XXXVII, Figures 2–6.

The types of this species are No. 4514*a* (3765) and No. 4514*b* (3766). These specimens are both from Hakel.

No. 4514*a* (3765) (Pl. xxxvii, Fig. 2) presents a vertebral column extending from the extremity of the tail forward to an unknown distance behind the head. The length of the

part of the column present is 143 mm. No. 4514*b* (3766) (Pl. XXXVII, Figs. 3, 4) presents the head and 45 mm. of the vertebral column. It has belonged to a somewhat smaller specimen than the other. The striking feature of the vertebral axis of this form is that all the vertebræ, from the head to the tail, have been represented each by two rings or "bodies," apparently just such a condition as we find in the middle of the caudal region of *Amia* among living fishes and in that of *Eurycormus* of the Jurassic. That this condition exists in the species before us is shown by the fact that throughout the series only alternate vertebral centra possess neural spines, while in the caudal region only those centra bear hæmal spines which have neural spines.

In view of my results in the study of the vertebral column of *Amia* (Field Columbian Mus. Pubs., Zoöl. Ser., I, p. 37, 1895), I hold that a vertebral ring possessing a neural arch and one without such an arch together constitute the equivalent of such a vertebra as we find in ordinary fishes; and that the archless ring belongs, not with the ring situated immediately in front of it, but with the one just behind it. In the species before us the rings, or "bodies," which have no neural spines appear to possess neural arches, and thus seem to differ from the corresponding elements in *Amia*. However, in the tail of *Amia* the rings which have no neural arches have their upper halves formed from ossifications which develop on the upper surface of the notochord and on each side of the myelon; and there appears to be no reason why these ossifications should not sometimes grow upward and form an arch over the myelon. Such an arch would not, however, be the equivalent of the arch which develops the spine, since this arch is formed, in *Amia* at least, by a pair of bones distinct from the centrum on which it rests.

For reasons detailed in the paper referred to, I shall call the 'centrum' which is devoid of either neural spine or hæmal arch an epihypocentrum; that provided with either or both arches, a pleurohæmacentrum. The former corresponds with what Dr. Zittel and others call the hypocentrum; the latter with what is called a pleurocentrum.

In the species before us I find 17 vertebral rings in a length of 10 mm. in the larger specimen, and 23 in the same length of the smaller one. The pleurohæmacentra are usually somewhat shorter than their companion rings. Both have their neural arches low and extending backward so as to overlap the arch just behind it. The epihypocentra present a short backwardly directed spine and a shorter process which extends forward somewhat over the arch in front. The pleurohæmacentra possess neither process. Both kinds of centra send downward a rather broad, short process, that of the epihypocentrum being apparently somewhat longer. No ribs are found articulating with any of these processes. Both the pleurohæmacentra and the epihypocentra are constricted about the middle. I have not been able to determine whether or not they permitted the passage of the notochord.

When we come to examine the caudal region we find the pleurohæmacentra not especially different from those of the abdominal region (Pl. XXXVII, Fig. 6). The inferior processes are, however, somewhat smaller. On the other hand, the epihypocentra are furnished with well-developed hæmal arches. These can be seen to continue to near the tip of the tail. Altogether there are close to 275 vertebral rings preserved in the larger specimen. Of these about 170 belong to the caudal portion of the body. This would indicate that in the tail there are 85 complete vertebræ.

No traces are seen anywhere of either fin rays or of interneural or interhæmal bones. All were probably absent. The extremity of the tail is shown only by a faint impression on the matrix, and there are no traces of a caudal fin. Likewise, there are no indications anywhere of scales.

The head of this species appears to be remarkably small. Its length in the smaller specimen, measured to the occiput, is only 4.5 mm.; but, including the branchiostegal rays, 9.5 mm. Its height is 1.5 mm. The snout appears to have been conical. In the jaws are small teeth in more than a single row. The branchiostegal rays are slender, much longer than the skull, and the hinder ends are somewhat curved upward. No opercular bones or pectoral arch is present.

BERYCIDÆ.

Pycnosterinx levispinosus, sp. nov.

PLATE XXXVI, FIGURE 4.

This small species was found at Hajula. The number of the type and only specimen is 4528 (3671).

This has been a very short-bodied, elevated, and compressed fish. It is possible that distortion has somewhat diminished its length, but of this there is no evidence. The length from the snout to the base of the caudal fin is 29 mm., while the greatest depth is 30 mm. The length of the head to the border of the operculum is 12.5 mm. The body has been covered with scales of moderate size. Whether or not these were ctenoid is yet uncertain. There is some indication that they were feebly ctenoid. The scales have also covered the bases of the dorsal and anal fins.

The dorsal fin has been composed of 7 or 8 spines and apparently 16 soft rays. Seven spines are present, but it seems probable that the most anterior one has been eroded away. The spines are stout and entirely smooth. The tip of the hindermost has apparently been segmented, but its size makes it proper to count it with the spines. Through erosion of portions of the bone it is seen that the spines and the supporting interneurals have been hollow, their lumen being now filled with calcite. It is also revealed that the notochord passed continuously through the vertebral centra.

The anal fin has had 3 or 4 spines and 10 to 12 soft rays. It seems probable that the most anterior one has been weathered away. These spines are stout and smooth.

The caudal fin has been forked. The pectoral fin is present in its natural position, but the rays have been damaged. The ventrals arise below the pectoral. The spine has been stout, and long enough to reach to the first soft rays of the anal fin. It is now represented mostly by its imprint in the matrix.

From the other species of the genus found at Mount Lebanon, except *P. dubius*, this species differs in the greater number of dorsal spines and smaller number of soft rays.

From *P. dubius* it differs in having fewer soft rays in the dorsal and anal fins, and in having these smooth, instead of ribbed.

The possibility that this fish is specifically identical with the one here described as *Aipichtys formosus* has not escaped the attention of the writer. Were the dorsal spines present in the latter species, this question could be settled more satisfactorily. It is regarded as belonging to *Aipichtys* rather than to *Pycnosterinx*, because the scales are smooth-edged, and there appear to be thickened scales along the border of the abdomen. Aside from the generic differences, *Pycnosterinx levispinosus* has almost certainly been a deeper-bodied fish. If we measure the distance from the anterior anal spine to the anterior soft rays of the dorsal in the two fishes, we find that in *P. levispinosus* this measurement is equal to the distance from the base of the caudal fin to the snout; while in the case of *Aipichtys formosus* the dimension will be equal only to the distance from the caudal base to the front of the opercular apparatus. Again, the ventral spine of *P. levispinosus* extends backward to the first soft ray of the anal fin, while in *A. formosus* it reaches only to the first spine. Lastly, there do not seem to have been any thickened scales on the abdomen of *P. levispinosus.*

CARANGIDÆ.

Aipichtys formosus, sp. nov.

PLATE XXXII, FIGURES 2 AND 3.

Of this supposed new species there is in the collection only a single specimen, No. 4519 (3831). This is incomplete, the head and the anterior portion of the body being broken away from about the articulation of the lower jaw to the middle of the dorsal fin. As a consequence, various characters are undetermined, and we cannot be wholly certain regarding the generic position of the fish.

No dorsal spines remain in the specimen. Of the articulated rays there are 13 present; possibly, but not certainly, all that were possessed by the fish. The anal fin comprises

4 short stout, spines and 12 articulated rays. The longest anal spine is only 7 mm. long, and all the spines are entirely smooth. The ray which I recognize as the first articulated one is very stout and resembles one of the spines, but it is divided and articulated at the distal end.

The base of the left pectoral fin is present. The pelvic fin has its origin directly below the pectoral. The first ray is long and thick, the length being 13 mm. and the extremity reaching the anal fin. There are at least 5, and possibly 6 or 7, articulated rays; but the number cannot be definitely determined. The caudal fin is forked, but the extremities of the rays are not exposed. Seven branchiostegal rays are counted. There are 14 caudal vertebræ.

The scales are thin, and their hinder borders have a perfectly smooth edge. They are rather large, there being about 8 longitudinal rows above the vertebral column and 12 below it. The greatest height of the body equals 38 mm.; the distance from the pectoral arch to the base of the caudal is about 28 mm.

This fish has been assigned provisionally to the genus *Aipichtys*, but it possibly belongs to *Acrogaster*, of the Berycidæ. Nothing is known regarding the structure of the head, and the number of the pelvic soft rays is uncertain. The rather large scales suggest *Acrogaster;* while, on the other hand, there appears to be a series of thickened scales along the lower edge of the abdomen, as in *Aipichtys*.

From all the described species of *Aipichtys* this differs in having a smaller number of anal rays.

From *Acrogaster heckelii* this fish differs in having a greater number of anal spines and a smaller number of articulated rays.

Collected at Hajula.

List of the Fishes found at the Three Fish-bearing Localities of Mount Lebanon.

Sahel Alma.	Hakel.	Hajula.
	HEXANCHIDÆ.	
Heptranchias? gracilis.		
	SCYLLIIDÆ.	
Scylliorhinus elongatus. Scylliorhinus curtirostris. Scylliorhinus tumidens. Mesiteia sahel-almæ.		
	LAMNIDÆ.	
Scapanorhynchus lewisii. Scapanorhynchus elongatus. Otodus latus.	Otodus sulcatus.	
	SQUALIDÆ.	
Squalus latidens S. ? primævus.		
	SQUATINIDÆ.	
Squatina crassidens.		
	PRISTIDÆ.	
Sclerorhynchus atavus.		Sclerorhynchus solomonis. Sclerorhynchus hiram. " sentus.
	RHINOBATIDÆ.	
Rhinobatus tenuirostris. Rhinobatus intermedius. Rhinobatus latus.	Rhinobatus maronita.	Rhinobatus eretes.
	RAJIDÆ.	
Raja primarmata. " minor.	Raja expansa.	Raja whitfieldi.
	DASYATIDÆ.	
	Cyclobatis oligodactylus. Cyclobatis major.	Cyclobatis oligodactylus.

Sahel Alma.	Hakel.	Hajula.
	BELONORHYNCHIDÆ?	
	Stenoprotome hamata.	
	PYCNODONTIDÆ.	
	Coccodus armatus. " lindstrœmi. Xenopholis carinatus. Palæobalistum gœdeli.	Coccodus insignis.
	MACROSEMIIDÆ.	
	Petalopteryx syriacus. " dorsalis.	
	OLIGOPLEURIDÆ.	
	Spathiurus dorsalis.	
	ELOPIDÆ.	
Holcolepis gracilis. " attenuatus. Spaniodon blondeli. " elongatus. " latus. Thrissopteroides tenuiceps. Thrissopteroides pulcher. Istieus lebanonensis.	Holcolepis attenuatus? " sardinioides. " lewisi.	Holcolepis lewisi.
	ICHTHYODECTIDÆ.	
	Eubiodectes libanicus.	Eubiodectes libanicus.
	CTENOTHRISSIDÆ.	
	Ctenothrissa vexillifer. " ovalis.	Ctenothrissa signifer.
	CLUPEIDÆ.	
Histiothrissa crassipinna.	Pseudoberyx syriacus. " bottæ. " grandis. Scombroclupea macrophthalma. Scombroclupea gaudryi. Diplomystus brevissimus. Diplomystus birdi.	Pseudoberyx syriacus. Scombroclupea macrophthalma. Scombroclupea gaudryi. Diplomystus brevissimus.

Sahel Alma	Hakel	Hajula
	HALOSAURIDÆ	
Enchelurus syriacus.		
	NOTACANTHIDÆ.	
Pronotacanthus sahelalmæ.		
	DERCETIDÆ.	
Leptotrachelus triqueter.	Leptotrachelus serpentinus.	Leptotrachelus serpentinus.
Leptotrachelus gracilis.	Leptotrachelus hakelensis.	
	ENCHODONTIDÆ.	
Enchodus longidens.		
" major.	Enchodus marchesettii.	Enchodus marchesettii?
Pantopholis dorsalis.	Eurypholis boissieri.	Eurypholis boissieri.
	Halec microlepis.	Halec microlepis.
	Prionolepis cataphractus.	Prionolepis cataphractus.
	Prionolepis laniatus.	
	MYCTOPHIDÆ.	
Osmeroides megapterus.	Osmeroides woodwardi.	
Osmeroides pusillus.	Osmeroides pontivagus.	Osmeroides pontivagus.
	Osmeroides ornatus.	
Acrognathus libanicus.	Acrognathus dodgei.	Acrognathus dodgei.
Leptosomus macrurus.	Leptosomus minimus.	Leptosomus minimus.
	Nematonotus bottæ.	Nematonotus bottæ.
	" longispinus.	" longispinus.
Opistopteryx gracilis.	Micrococœlia libanica.	Micrococœlia dayi.
Rhinellus furcatus.		Rhinellus delicatus.
" ferox.		
" damoni.		
	GONORHYNCHIDÆ.	
Charitosomus major.	Charitosomus hakelensis.	
" lineolatus.		
	CHIROTHRICIDÆ.	
Chirothrix libanicus.	Telepholis? tenuis.	
" lewisi.	Exocœtoides minor.	Exocœtoides minor.
	ANGUILLIDÆ.	
Urenchelys avus.	Urenchelys hakelensis.	Urenchelys germanus.

Sahel Alma.	Hakel.	Hajula.
	ANGUILLAVIDÆ.	
	Anguillavus bathshebæ.	Anguillavus quadripinnis. Anguillavus bathshebæ.
	ENCHELIIDÆ.	
	Enchelion montium.	
	BERYCIDÆ.	
Acrogaster heckeli. " davisi. Pycnosterinx russeggeri. Pycnosterinx discoides. " gracilis. " dubius. " elongatus. " latus. Hoplopteryx syriacus. " stachei. " oblongus. Dinopteryx spinosus.	Hoplopteryx lewisi.	Pycnosterinx levispinosus. Hoplopteryx lewisi.
	STROMATEIDÆ.	
Orosoma sahel-almæ. " intermedium. " pulchellum.		
	CARANGIDÆ.	
	Aipichtys velifer. " minor.	Aipichtys formosus. " minor.

An examination of the lists given above shows that the beds at Sahel Alma contain an assemblage of species which is quite different from that found at either of the other localities; furthermore, that the fauna of Hajula closely resembles that of Hakel. From Sahel Alma there have been collected 62 species; from Hakel, 50 species; and from Hajula, 34 species. Of those obtained at Sahel Alma it is not certain that a single species has been collected at either of the other localities. It is possible that *Holcolepis attenuatus*, of Sahel Alma, occurs also at Hakel, and that *Enchodus longidens* is common to all three localities; but this is not yet proved. On the other hand, out of the 34 species found at Hajula, 20 are

common to this place and Hakel. This indicates that the fish-bearing beds of these two localities are on nearly the same geological level. In case the deposits are not synchronous, can we reach any conclusion regarding their relative ages?

We observe that the Hajula fauna is related to that of Sahel Alma by the presence of three genera which are not found at Hakel, viz., *Sclerorhynchus*, *Rhinellus*, and *Pycnosterinx*. Furthermore, that pycnodonts, especially abundant during the Jurassic, are well represented at Hakel, but by only a single species at Hajula; that, of *Pseudoberyx*, there are three species at Hakel, and only one, so far as we know, at Hajula. While too great reliance must not be placed on these observations, they appear to indicate that the beds at Hakel are the lowest; that these are followed at no great distance by those at Hajula; and that those at Sahel Alma are considerably above the latter. That the latter beds are higher in the series than those at Hakel has been the conclusion of most geologists. This is further confirmed by the occurrence of Macrosemiidæ, one oligopleurid, and many pycnodonts at Hakel; while at Sahel Alma there are few or none of these, but many Berycidæ, altogether 12 species. The large number of sharks found at Sahel Alma, mostly belonging to living genera, may be regarded as indicating a more recent time than that during which the beds of the other localities were deposited.

Explanation of the Abbreviations employed on the Plates.

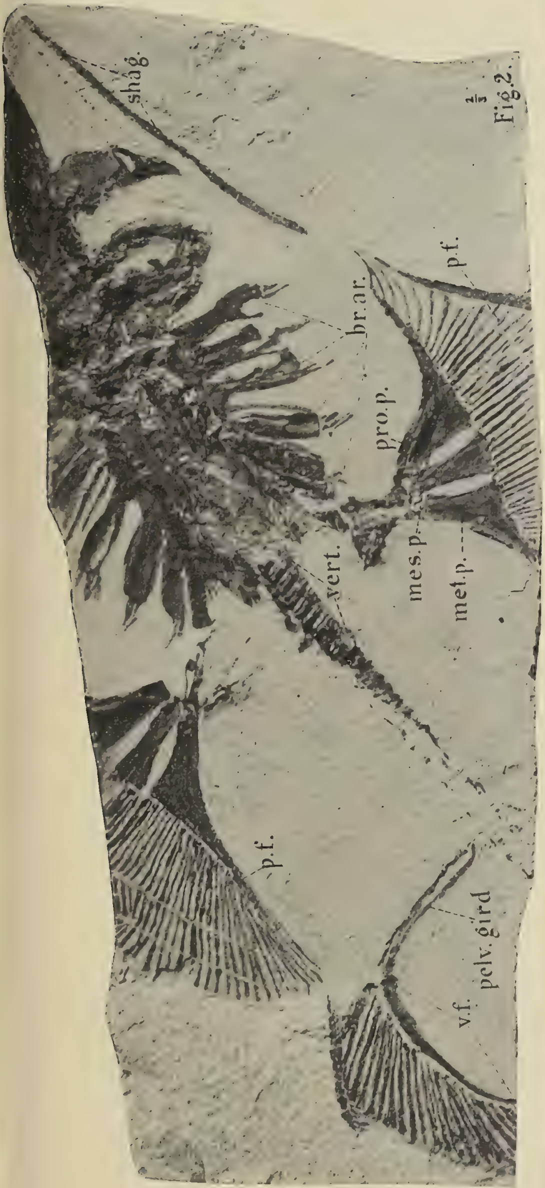
a. f. anal fin.
ant. pr. anterior transverse process (*Leptotrachelus*).
br. branchiostegals.
br. ar. branchial arches.
c. f. caudal fin.
cl. cleithrum.
cran. cranium.
cr. sc. crimped scales (*Microcœlia*).
den. dentary.
derm. sc. dermal scutes.
d. f. dorsal fin.
d. r. dorsal fin ray.
d. sc. dorsal scutes.
ep. hy. epihypocentrum.
h. a. hæmal arch.
hy. hyoid.
hym. hyomandibular.
int. intestine.
i. op. interoperculum.
lat. sc. lateral scutes.
mes. pt. mesopterygoid.
met. pt. metapterygoid.
mo. mouth.

mx. maxilla.
na. cp. nasal capsule.
nar. nares.
n. sp. neural spines.
oc. occiput.
op. operculum.
orb. orbit.
par. parasphenoid.
pelv. gird. pelvic girdle.
pl. h. pleurohæmocentrum.
p. op. preoperculum.
post. pr. posterior transverse process.
pro. p. propterygium.
p. sp. pectoral spine.
pt. pterygoid.
qu. quadrate.
rost. rostrum.
rost. t. rostral teeth.
shag. shagreen.
s. op. suboperculum.
spl. t. splenial teeth.
v. a. neural arches.
v. c. vertebral centra.
v. f. ventral fin.
v. f. s. ventral fin support.

EXPLANATION OF PLATE XXIV.

FIG. 1.—*Sclerorhynchus* sp. undet. Page 398. Trunk from near pectoral fin to near root of caudal fin. $\times\frac{2}{3}$. No. 4502 (3686). *d. f'*, anterior dorsal fin; *d. f.''*, posterior dorsal fin; *v. f.*, ventral fin. Anteriorly is seen the skeleton of a swallowed fish.

FIG. 2.—*Rhinobatus eretes* Hay. Page 404. Part of head and part of trunk. Type. $\times\frac{2}{3}$. No. 4500 (3715). *br. ar.*, branchial arches; *mes. p.*, mesopterygium; *met. p.*, metapterygium; *p. f.*, pectoral fin; *pelv. gird.*, pelvic girdle; *pro. p.*, propterygium; *shag.*, shagreen; *v. f.*, ventral fin; *vert.*, vertebræ.

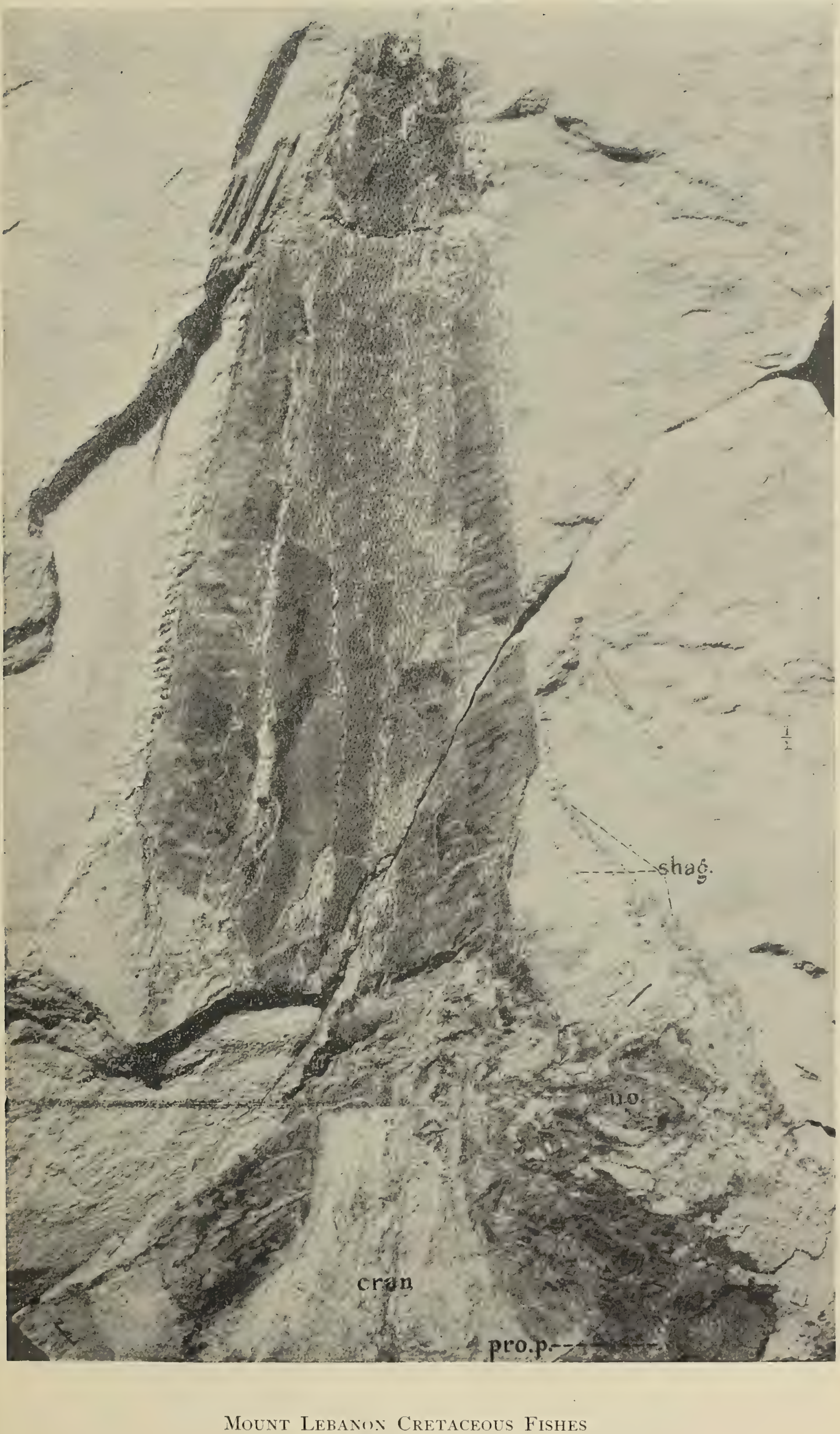


MOUNT LEBANON CRETACEOUS FISHES

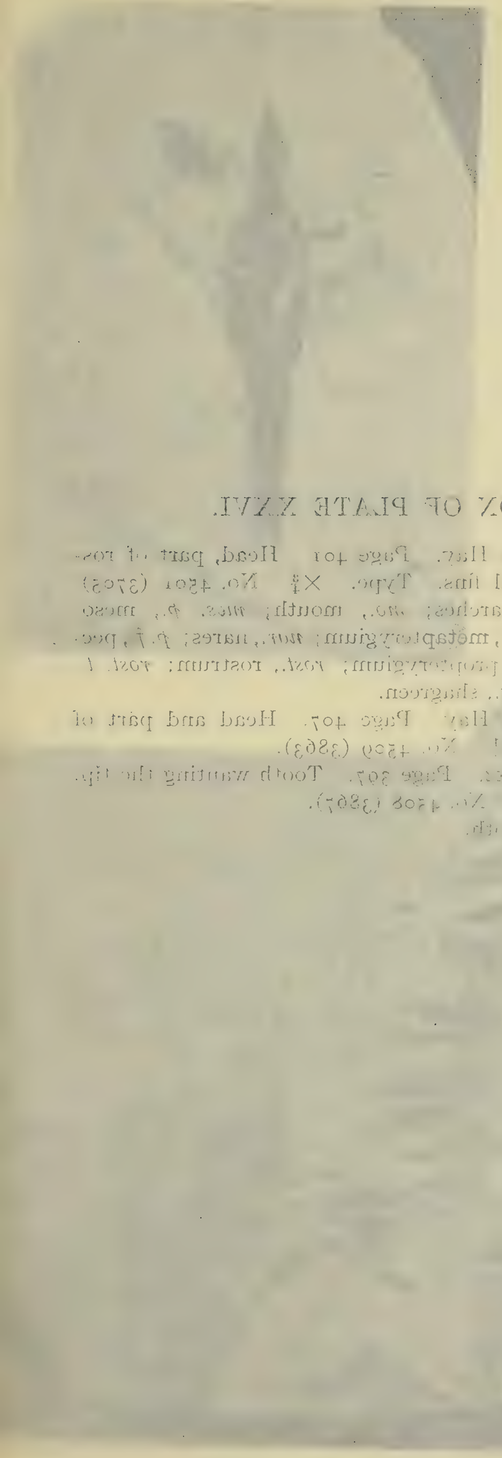
Mount Lebanon Cretaceous

EXPLANATION OF PLATE XXV.

Sclerorhynchus solomonis Hay. Page 399. Rostrum and portion of cranium and pectoral fin. Type. $\times\frac{1}{1}$. No. 4503 (3706). *cran.*, cranium; *mo.*, mouth; *pro. p.*, portion of propterygium; *shag.*, shagreen. On the left side of the rostrum are seen some of the rostral teeth.



MOUNT LEBANON CRETACEOUS FISHES



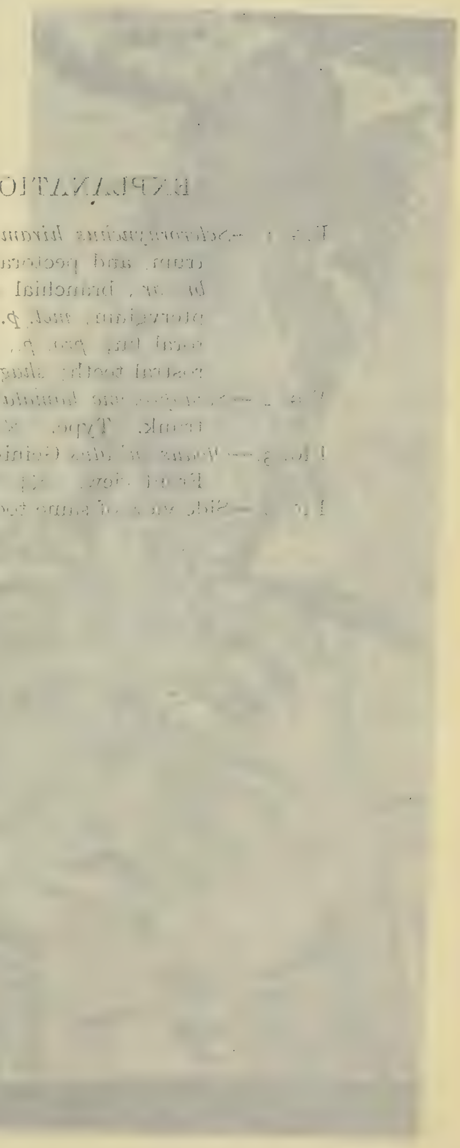


Fig. 3

Fig. 4

EXPLANATION OF PLATE XXVI.

FIG. 1.—*Sclerorhynchus hiram* Hay. Page 401. Head, part of rostrum, and pectoral fins. Type. $\times\frac{3}{4}$. No. 4501 (3705). *br. ar.*, branchial arches; *mo.*, mouth; *mes. p.*, mesopterygium; *met. p.*, metapterygium; *nar.*, nares; *p. f.*, pectoral fin; *pro. p.*, propterygium; *rost.*, rostrum; *rost. t.*, rostral teeth; *shag.*, shagreen.

FIG. 2.—*Stenoprotome hamata* Hay. Page 407. Head and part of trunk. Type. $\times\frac{1}{1}$. No. 4509 (3863).

FIG. 3.—*Otodus sulcatus* Geinitz. Page 397. Tooth wanting the tip. Front view. $\times\frac{1}{1}$. No. 4508 (3867).

FIG. 4.—Side view of same tooth.

Fig. 2.

1/1

Fig. 3.

1/1

Fig. 4.

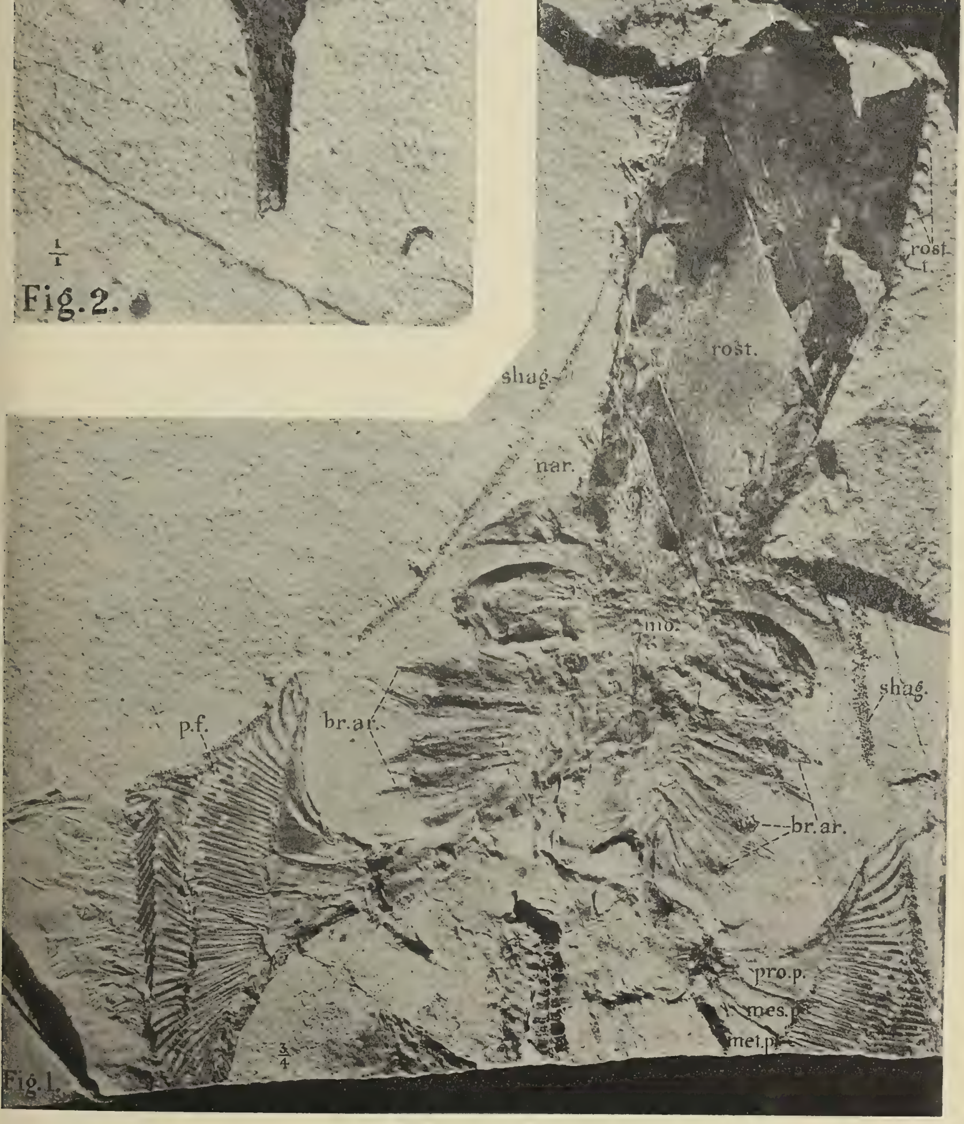
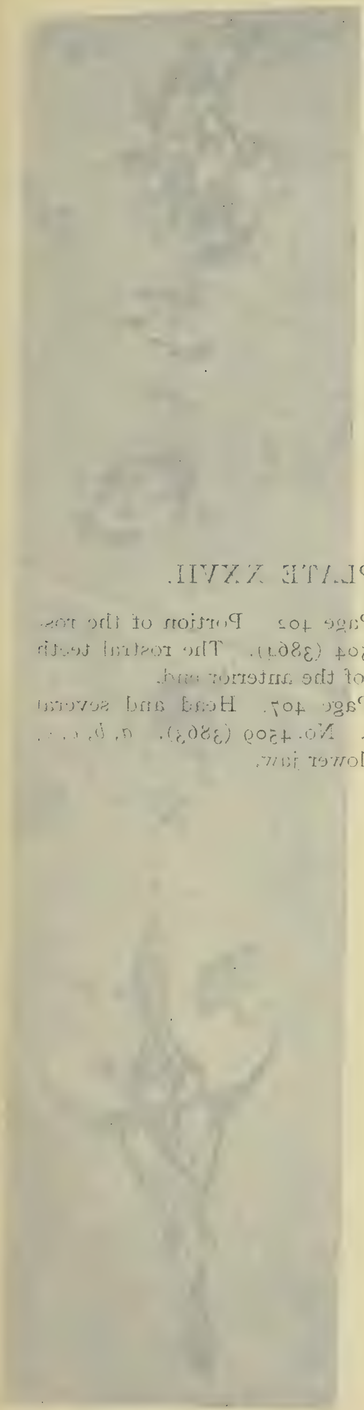
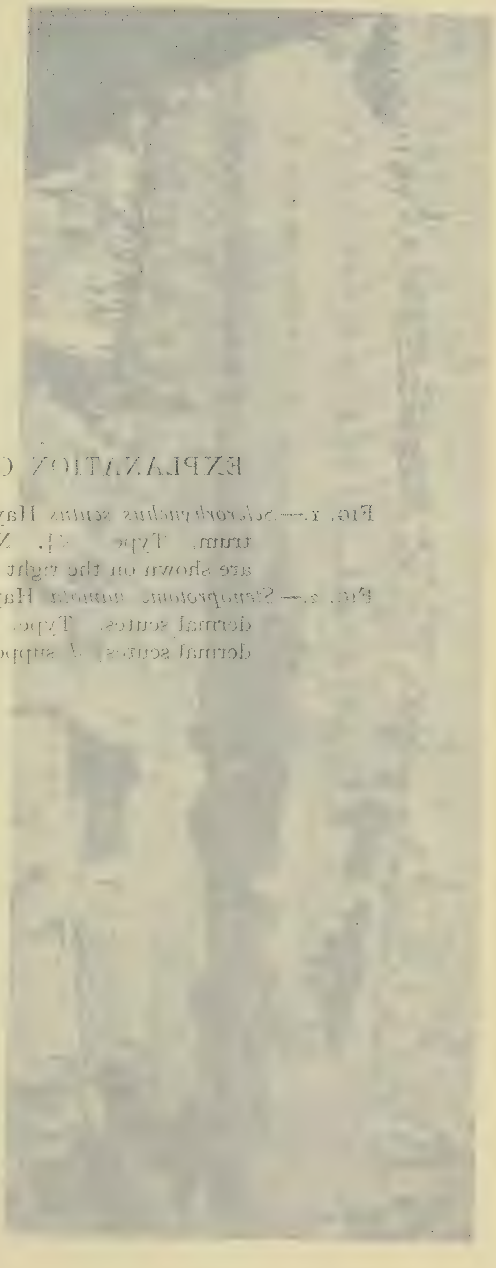


Fig. 1.

Mount Lebanon Cretaceous Fishes





EXPLANATION OF PLATE XXVII.

Fig. 1.—*Sclerorhynchus sentus* Hay. Page 402. Portion of the rostrum. Type. $\times \frac{1}{1}$. No. 4504 (3864). The rostral teeth are shown on the right side of the anterior end.

Fig. 2.—*Stenoprotome hamata* Hay. Page 407. Head and several dermal scutes. Type. $\times \frac{1}{1}$. No. 4509 (3863). *a*, *b*, *c*, *e*, dermal scutes; *d*, supposed lower jaw.

MOUNT LEBANON CRETACEOUS FISHES

EXPLANATION OF PLATE XXVIII.

Raja whitfieldi Hay. Page 405. Head and trunk. Type. $\times \frac{1}{1}$. No. 4505*b* (3708). *mo.*, mouth; *na. cp.*, nasal capsule; *p. f.*, pectoral fin; *rost.*, rostrum; *v. f.*, ventral fin; *vert.*, vertebræ.

MOUNT LEBANON CRETACEOUS FISHES

EXPLANATION OF PLATE XXIX.

FIG. 1.—*Coccodus lindstrœmi* Davis. Page 409. Head. $\times\frac{1}{1}$. No. 4517*a* (3698). *d. f'.*, supposed anterior dorsal fin; *oc. sp.*, occipital spine; *orb.*, orbit.

FIG. 2.—*Coccodus insignis* Hay. Page 413. Fish wanting the tail. $\times\frac{1}{1}$. No. 4516*f* (3794). *d. f.*, dorsal fin; *n. sp.*, neural spine; *par.*, parasphenoid; *p. f.*, pectoral fin; *v. f.*, ventral fin; *v. f. s.*, ventral fin support.

FIG. 3.—*Coccodus insignis* Hay. Page 410. View of occipital spine. Cotype. $\times\frac{1}{1}$. No. 4516*b* (3700). *oc.*, occiput; *oc. sp.*, occipital spine.

FIG. 4.—*Coccodus insignis* Hay. Page 411. View of fish from below. Cotype. $\times\frac{1}{1}$. No. 4516*d* (3702). *a. f.*, anal fin; *d. f.*, dorsal fin.

FIG. 5.—*Coccodus insignis* Hay. Page 413. Head and part of trunk. $\times\frac{1}{1}$. No. 4516*c* (3701). *p. f.*, pectoral fin; *p. sp.*, pectoral spine; *spl. t.*, splenial teeth.

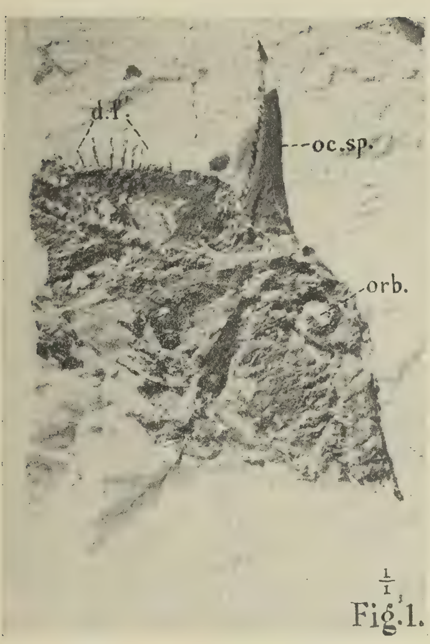


Fig. 1.

Fig. 2.

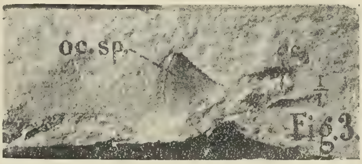
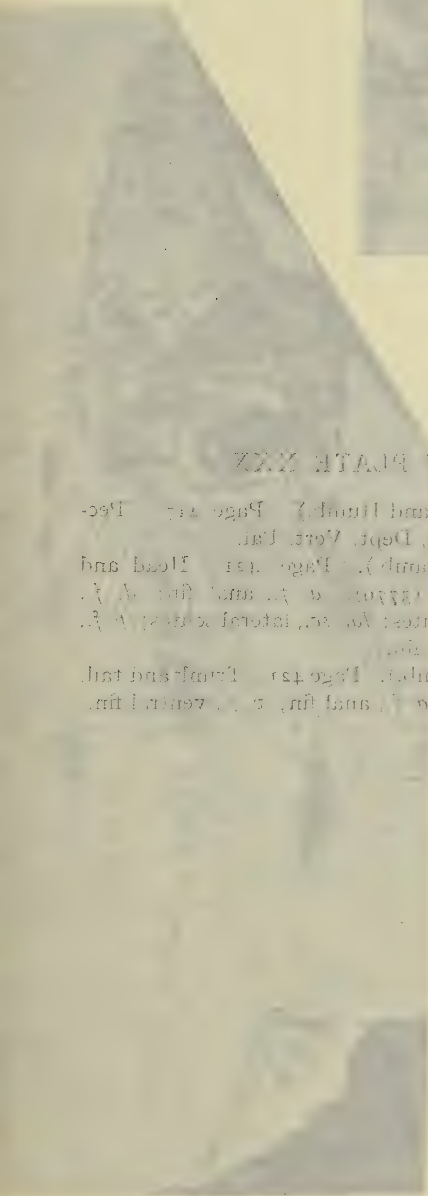


Fig. 3.

Fig. 4.

Fig. 5.

Mount Lebanon Cretaceous Fishes

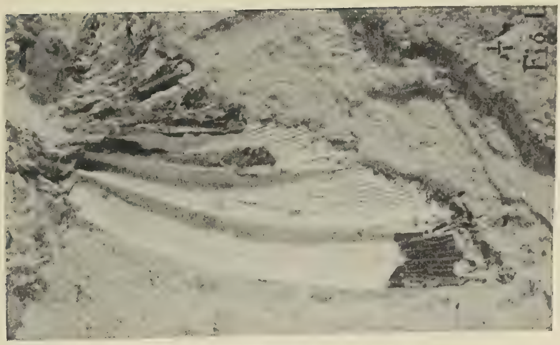


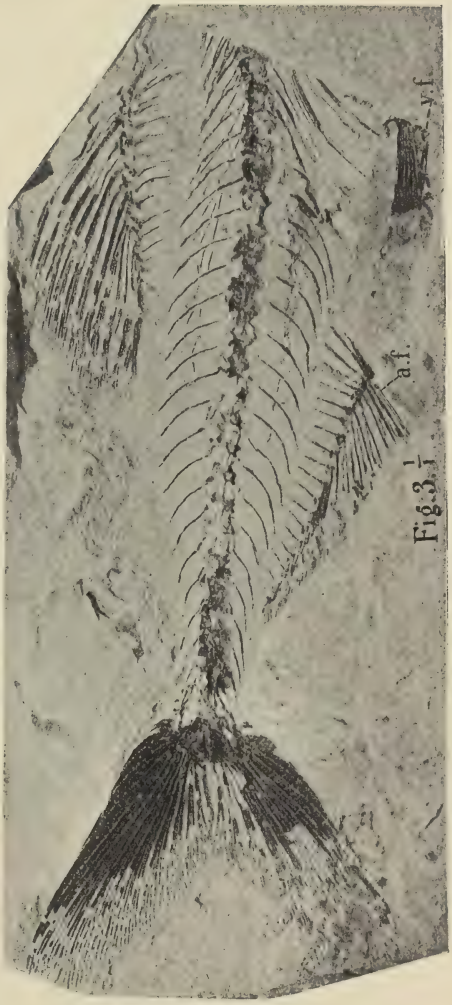
EXPLANATION OF PLATE XXX.

FIG. 1.—*Eubiodectes libanicus* (Pict. and Humb.). Page 417. Pectoral fin. $\times\frac{1}{1}$. No. 3899, Dept. Vert. Pal.

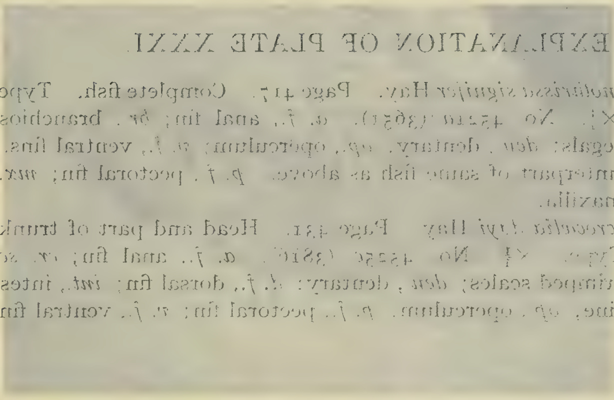
FIG. 2.—*Enchodus marchesettii ?* (Kramb.). Page 421. Head and trunk. $\times\frac{1}{1}$. No. 4507*a* (3779). *a. f.*, anal fin; *d. f.*, dorsal fin; *d. sc.*, dorsal scutes; *lat. sc.*, lateral scutes; *p. f.*, pectoral fin; *v. f.*, ventral fin.

FIG. 3.—*Enchodus marchesettii ?* (Kramb.). Page 421. Trunk and tail. $\times\frac{1}{1}$. No. 4507*b* (3859). *a. f.*, anal fin; *v. f.*, ventral fin.





MOUNT LEBANON CRETACEOUS FISHES

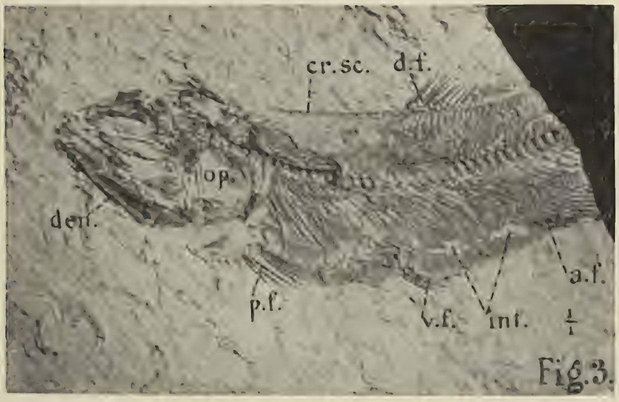


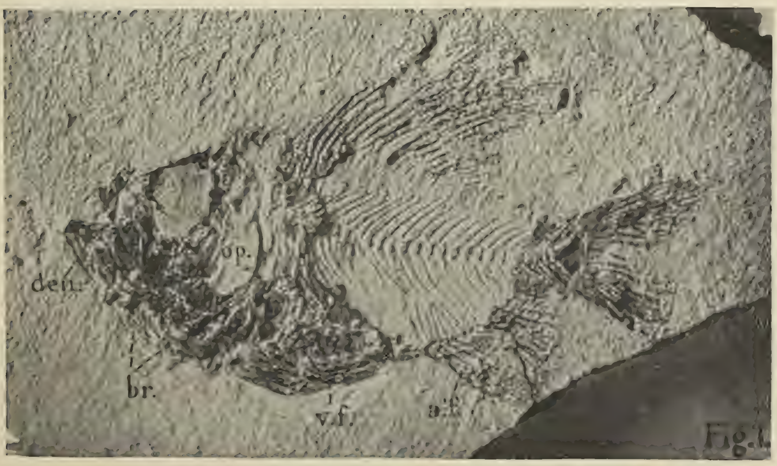
EXPLANATION OF PLATE XXXI.

FIG. 1.—*Ctenothrissa signifer* Hay. Page 417. Complete fish. Type. $\times\frac{1}{1}$. No. 4521*a* (3651). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *op.*, operculum; *v. f.*, ventral fins.

FIG. 2.—Counterpart of same fish as above. *p. f.*, pectoral fin; *mx.*, maxilla.

FIG. 3.—*Microcœlia dayi* Hay. Page 431. Head and part of trunk. Type. $\times\frac{1}{1}$. No. 4525*e* (3816). *a. f.*, anal fin; *cr. sc.* crimped scales; *den.*, dentary; *d. f.*, dorsal fin; *int.*, intestine; *op.*, operculum; *p. f.*, pectoral fin; *v. f.*, ventral fin.





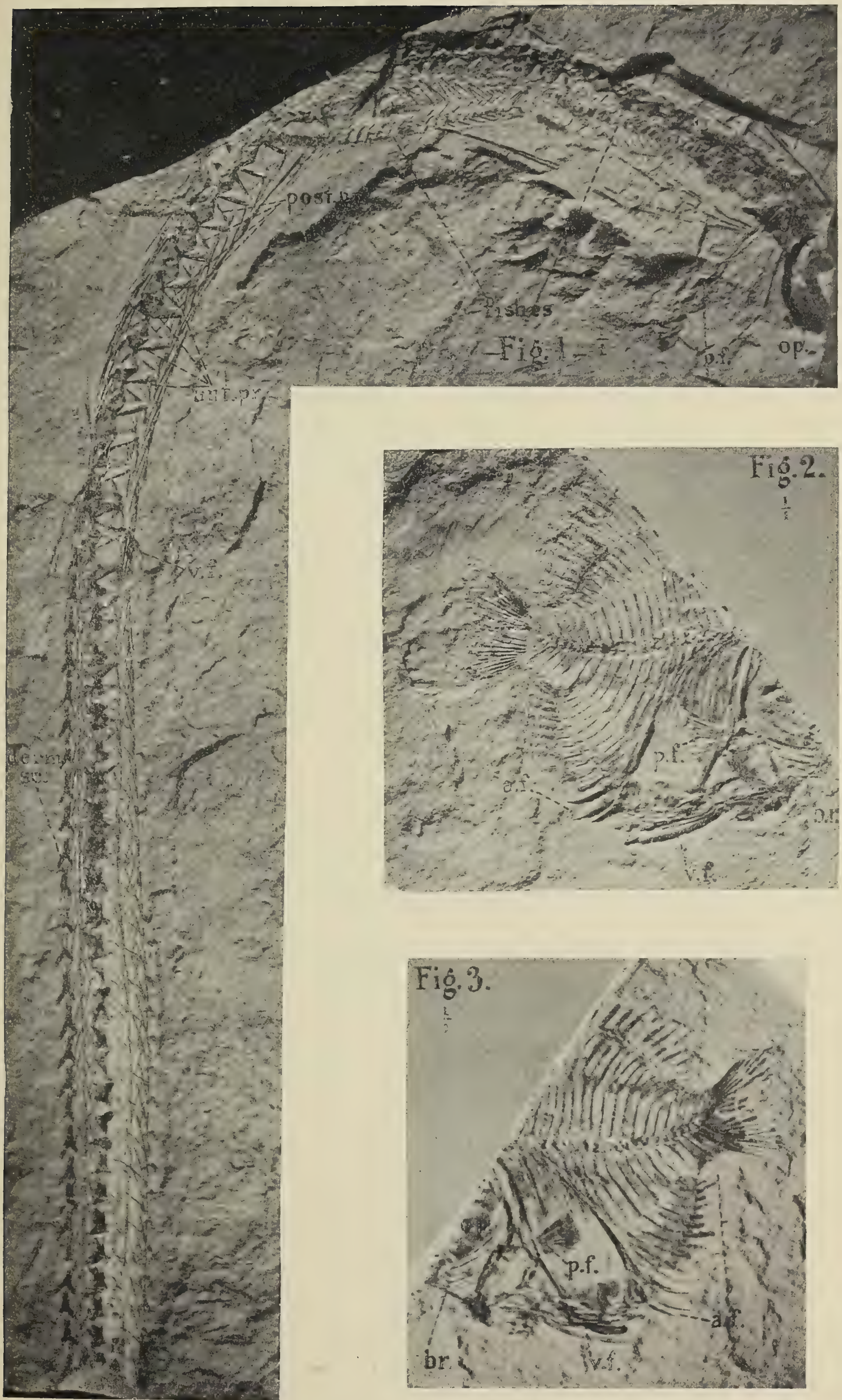
MOUNT LEBANON CRETACEOUS FISHES

MOUNT LEBANON CRETACEOUS FISHES

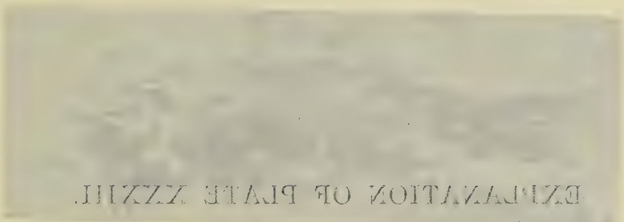
EXPLANATION OF PLATE XXXII.

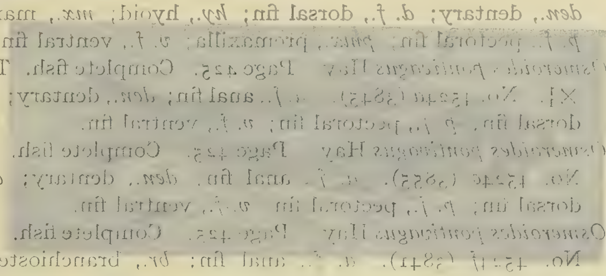
FIG. 1.—*Leptotrachelus serpentinus* Hay. Page 419. Trunk. Type. $\times\frac{1}{1}$. No. 4511*a* (3683). *ant. pr.*, anterior transverse processes of vertebræ; *derm. sc.*, dermal scutes; *op.*, operculum; *p. f.*, pectoral fin; *post. pr.*, posterior processes of vertebræ; *v. f.*, ventral fin.

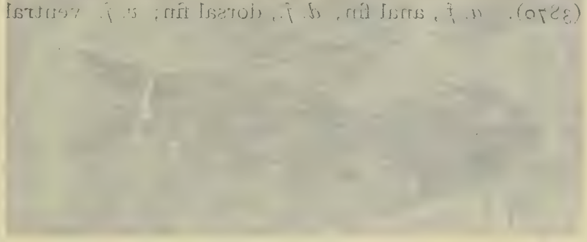
FIGS. 2 and 3.—*Aipichtys formosus* Hay. Page 445. Fish and its counterpart, without head. Type. $\times\frac{1}{1}$. No. 4519 (3831). *a. f.*, anal fin; *br.*, branchiostegals; *op.*, operculum; *p. f.*, pectoral fin; *v. f.*, ventral fin.



Mount Lebanon Cretaceous Fishes







EXPLANATION OF PLATE XXXIII.

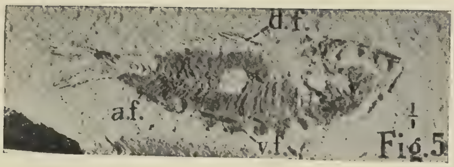
FIG. 1.—*Osmeroides pontivagus* Hay. Page 424. Complete fish. $\times\frac{1}{1}$. No. 4524*b* (3846). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *d. f.*, dorsal fin; *hy.*, hyoid; *mx.*, maxilla; *p. f.*, pectoral fin; *pmx.*, premaxilla; *v. f.*, ventral fin.

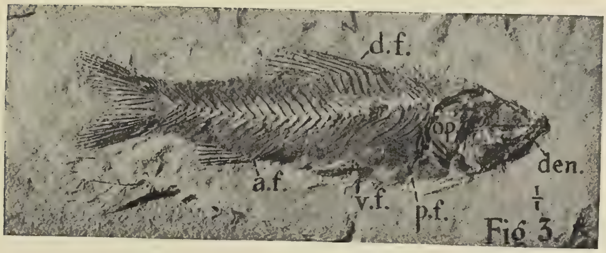
FIG. 2.—*Osmeroides pontivagus* Hay. Page 425. Complete fish. Type. $\times\frac{1}{1}$. No. 4524*a* (3845). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

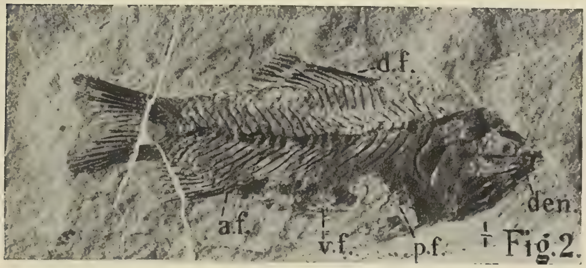
FIG. 3.—*Osmeroides pontivagus* Hay. Page 425. Complete fish. $\times\frac{1}{1}$. No. 4524*c* (3855). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

FIG. 4.—*Osmeroides pontivagus* Hay. Page 425. Complete fish. $\times\frac{1}{1}$. No. 4524*f* (3841). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

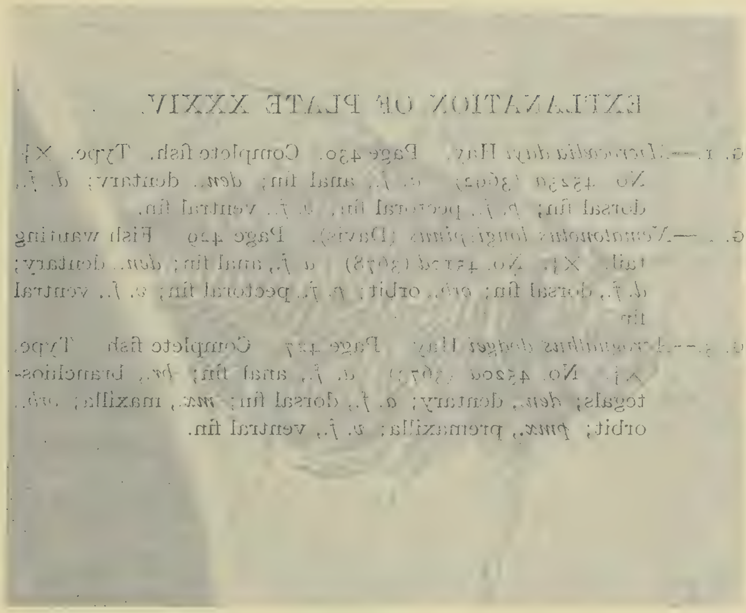
FIG. 5.—*Osmeroides ornatus* Hay. Page 426. Type. $\times\frac{1}{1}$. No. 4518 (3870). *a. f.*, anal fin; *d. f.*, dorsal fin; *v. f.*, ventral fin.







Mount Lebanon Cretaceous Fishes



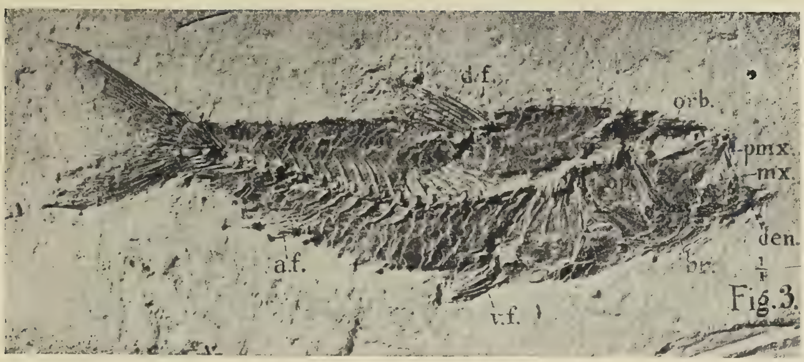
MOUNT LEBANON

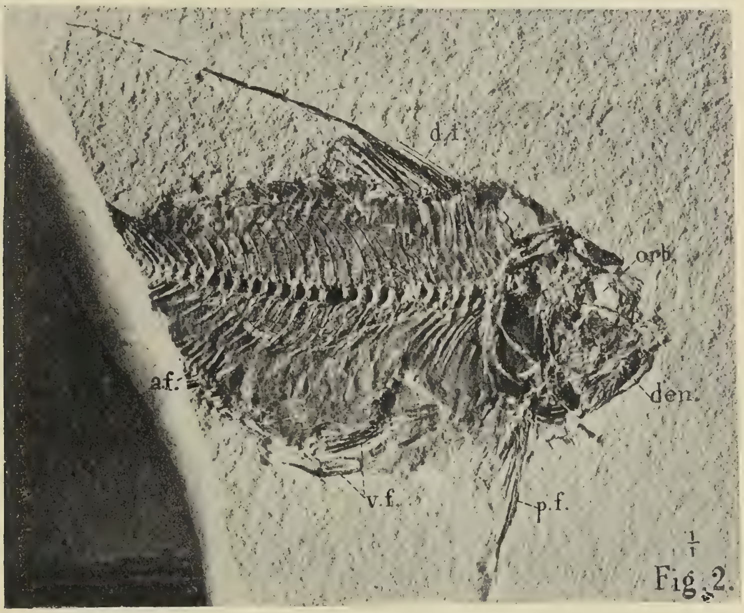
EXPLANATION OF PLATE XXXIV.

FIG. 1.—*Microcœlia dayi* Hay. Page 430. Complete fish. Type. $\times\frac{1}{1}$. No. 4525*a* (3692). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *p. f.*, pectoral fin; *v. f.*, ventral fin.

FIG. 2.—*Nematonotus longispinus* (Davis). Page 429. Fish wanting tail. $\times\frac{1}{1}$. No. 4510*d* (3678). *a. f.*, anal fin; *den.*, dentary; *d. f.*, dorsal fin; *orb.*, orbit; *p. f.*, pectoral fin; *v. f.*, ventral fin.

FIG. 3.—*Acrognathus dodgei* Hay. Page 427. Complete fish. Type. $\times\frac{1}{1}$. No. 4520*a* (3673). *a. f.*, anal fin; *br.*, branchiostegals; *den.*, dentary; *d. f.*, dorsal fin; *mx.*, maxilla; *orb.*, orbit; *pmx.*, premaxilla; *v. f.*, ventral fin.





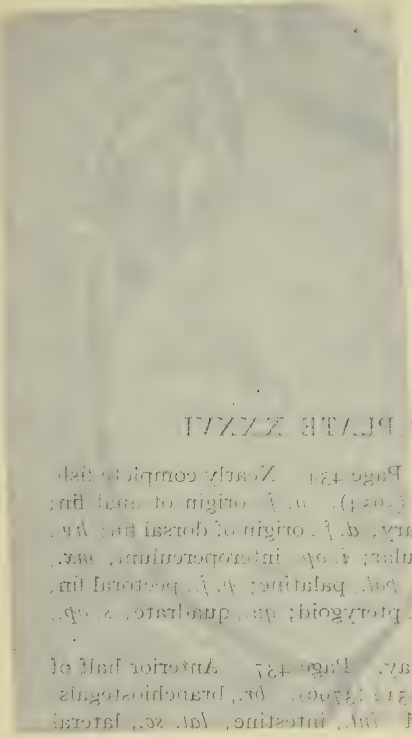
MOUNT LEBANON CRETACEOUS FISHES

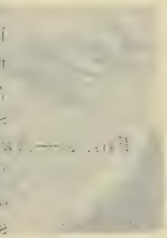
Mount Lebanon Cretaceous Fishes

EXPLANATION OF PLATE XXXV.

Nematonotus longispinus (Davis). Page 429. Complete fish. $\times\frac{1}{1}$. No. 4510*f* (3723). *a. f.*, anal fin; *den.*, dentary; *d. r.*, long dorsal ray; *op.*, operculum; *p. f.*, pectoral fin; *v. f.*, ventral fin.

Mount Lebanon Cretaceous Fishes





EXPLANATION OF PLATE XXXVI.

FIG. 1.—*Urenchelys germanus* Hay. Page 434. Nearly complete fish. Type. $\times\frac{1}{1}$. No. 4515*a* (3654). *a. f.*, origin of anal fin; *cl.*, cleithrum; *den.*, dentary; *d. f.*, origin of dorsal fin; *hy.*, hyoid; *hym.*, hyomandibular; *i. op.*, interoperculum; *mx.*, maxilla; *op.*, operculum; *pal.*, palatine; *p. f.*, pectoral fin; *p. op.*, preoperculum; *pt.*, pterygoid; *qu.*, quadrate; *s. op.*, suboperculum.

FIG. 2.—*Anguillavus quadripinnis* Hay. Page 437. Anterior half of fish. Type. $\times\frac{1}{1}$. No. 4512 (3796). *br.*, branchiostegals; *den.*, dentary; *hy.*, hyoid; *int.*, intestine; *lat. sc.*, lateral scutes; *mx.*, maxilla; *op.*, operculum; *p. f.*, pectoral fin; *pt.*, pterygoid; *qu.*, quadrate; *v. f.*, ventral fins.

FIG. 3.—Ventral fin of the same specimen as Fig. 2. Page 437. Enlarged 7 diameters. *v. f.*, ventral fins; *v. f. s.*, ventral fin supports.

FIG. 4.—*Pycnosterinx levispinosus* Hay. Page 444. Complete fish. Type. $\times\frac{1}{1}$. No. 4528 (3671).

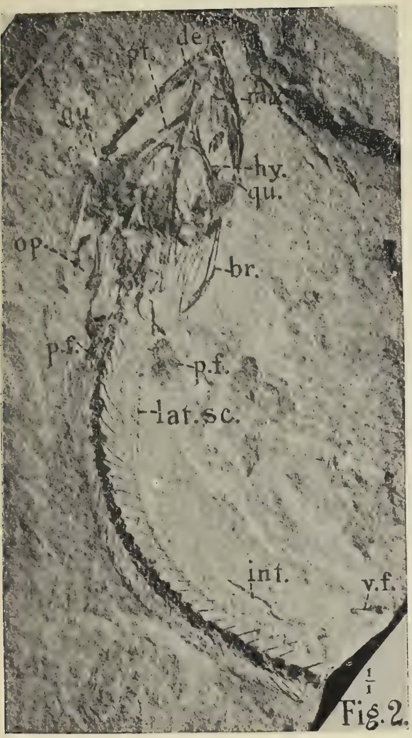


Fig. 2.

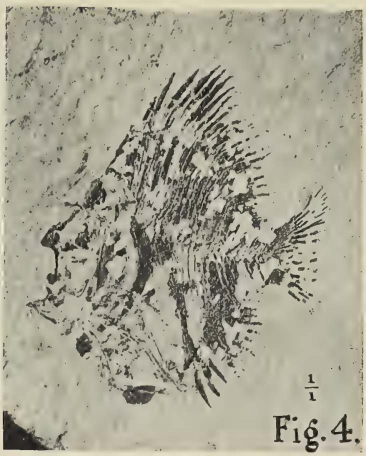


Fig. 4.

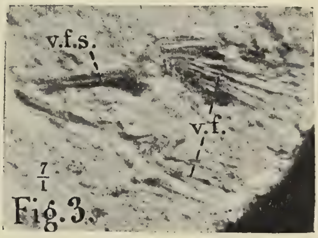
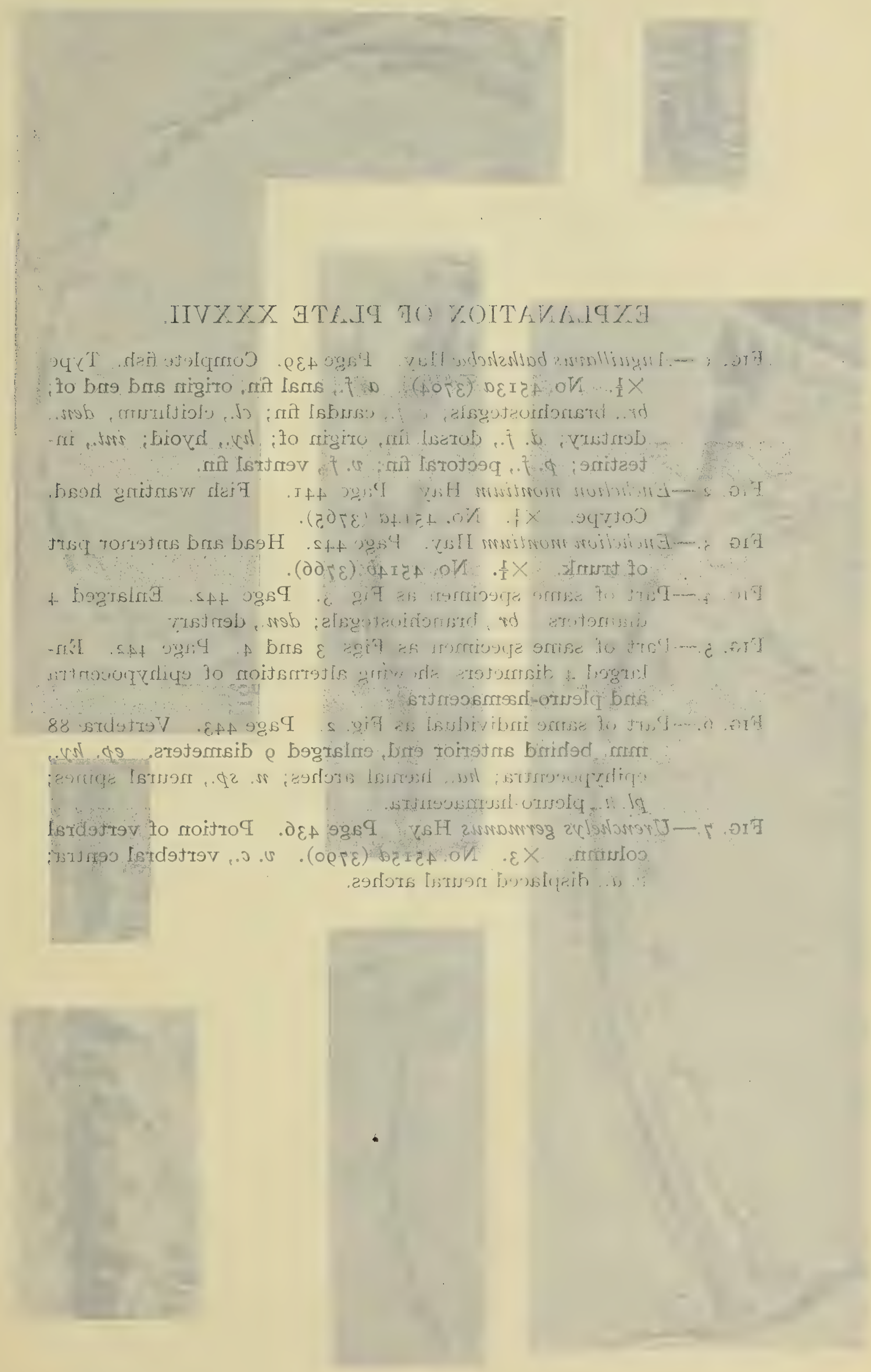


Fig. 3.

Fig. 1.

MOUNT LEBANON CRETACEOUS FISHES



MOUNT LEBANON CRETACEOUS FISHES

EXPLANATION OF PLATE XXXVII.

FIG. 1.—*Anguillavus bathshebæ* Hay. Page 439. Complete fish. Type $\times \frac{1}{1}$. No. 4513*a* (3704). *a. f.*, anal fin, origin and end of; *br.*, branchiostegals; *c. f.*, caudal fin; *cl.*, cleithrum; *den.*, dentary; *d. f.*, dorsal fin, origin of; *hy.*, hyoid; *int.*, intestine; *p. f.*, pectoral fin; *v. f.*, ventral fin.

FIG. 2.—*Enchelion montium* Hay. Page 441. Fish wanting head. Cotype. $\times \frac{1}{1}$. No. 4514*a* (3765).

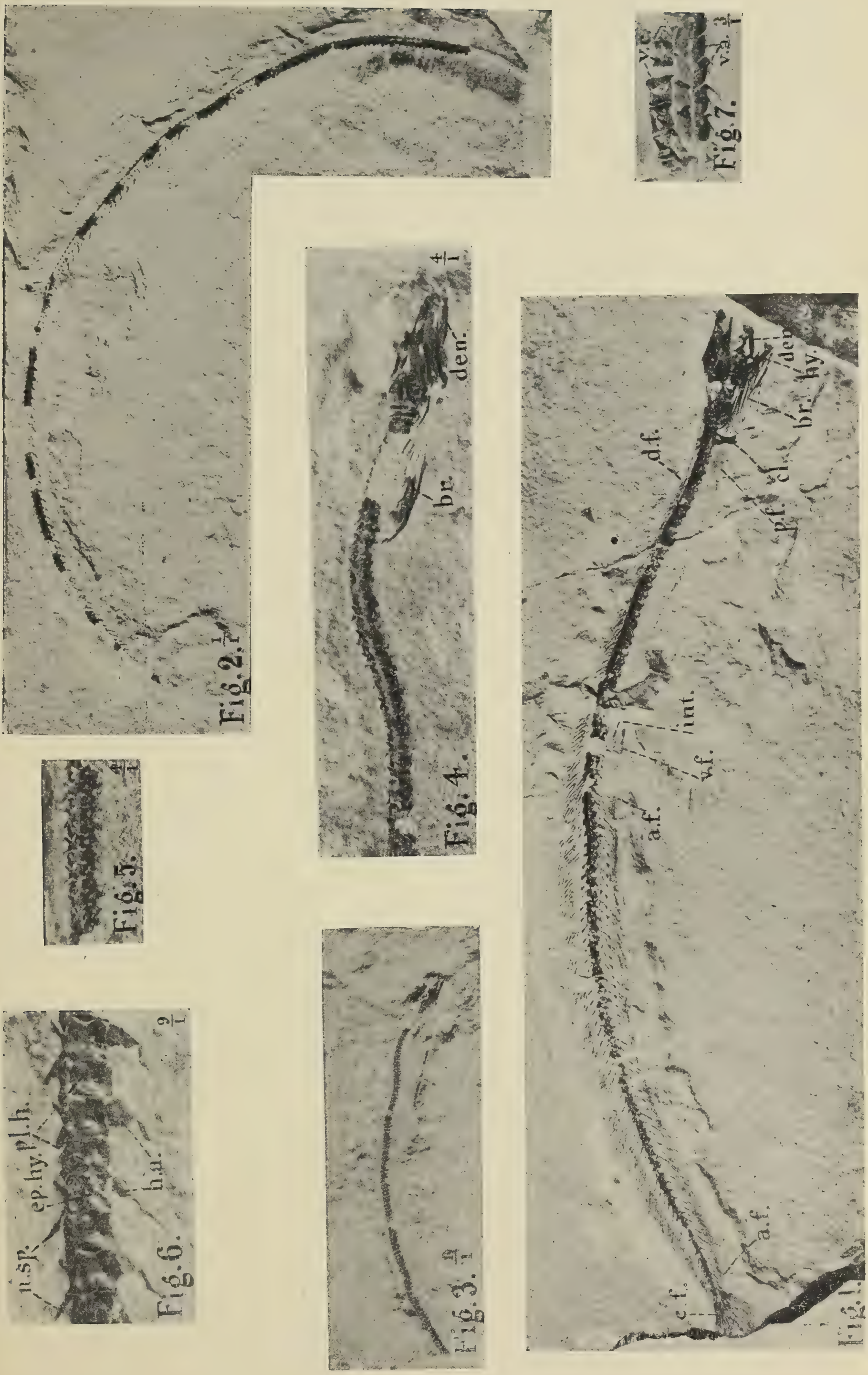
FIG. 3.—*Enchelion montium* Hay. Page 442. Head and anterior part of trunk. $\times \frac{1}{1}$. No. 4514*b* (3766).

FIG. 4.—Part of same specimen as Fig. 3. Page 442. Enlarged 4 diameters. *br.*, branchiostegals; *den.*, dentary.

FIG. 5.—Part of same specimen as Figs. 3 and 4. Page 442. Enlarged 4 diameters, showing alternation of epihypocentra and pleuro-hæmacentra.

FIG. 6.—Part of same individual as Fig. 2. Page 443. Vertebræ 88 mm. behind anterior end, enlarged 9 diameters. *ep. hy.*, epihypocentra; *ha.*, hæmal arches; *n. sp.*, neural spines; *pl. h.*, pleuro-hæmacentra.

FIG. 7.—*Urenchelys germanus* Hay. Page 436. Portion of vertebral column. $\times 3$. No. 4515*d* (3790). *v. c.*, vertebral centra; *v. a.*, displaced neural arches.



MOUNT LEBANON CRETACEOUS FISHES

Article XI. — A NEW SPECIES OF FOSSIL EDENTATE FROM THE SANTA CRUZ FORMATION OF PATAGONIA.

By Barnum Brown.

In the autumn of 1898 the American Museum of Natural History made arrangements with the Princeton University Museum for the writer to accompany the third expedition to Patagonia, under the leadership of Mr. J. B. Hatcher. The expenses of this trip were largely defrayed by Professor Henry Fairfield Osborn.

A large collection, comprising nine nearly complete skeletons and nearly a hundred skulls with skeletal material, was secured by the writer from exposures on the Rio Gallegos, on the seashore south of Rio Coy, and from the bluffs along the coast south of Rio Santa Cruz. This material represents most of the families that lived in such great numbers during the Santa Cruz period, and contains several new species.

By previous arrangement with Professor Scott and Mr. Hatcher, the portion of this material belonging to species already known will be described in the Princeton memoirs, while the new species will be described in the American Museum Bulletin.

Eucinepeltus complicatus, nov. sp.

This species is founded on an adult skull with cephalic shield, No. 9248 of the collection of the American Museum of Natural History. The type was found in the talus of cliffs on Rio Gallegos, near Mr. Felton's residence.

Comparison with the type of the genus, *Eucinepeltus petesatus*, has been possible through the kindness of Professor W. B. Scott, the advance sheets of whose memoir I have examined.

It differs from the type of the genus in the following characters:

	Eucinepeltus petesatus.	*Eucinepeltus complicatus.*
Pattern of teeth:	1st to 3rd non-lobate.	1st to 3rd-lobate.
Cephalic shield:	9 plates, not all pitted.	11 plates, all pitted.

The cephalic shield is composed of eleven plates in four rows, arranged in the following order from the anterior to the posterior end: 2 in the first, 3 in the second, 4 in the third, and 2 in the fourth rows. Each plate has a central pit which is of pronounced character in the two median plates of the third row. These pits have a circular shape, with raised margin, very rugose sides, and a small cone at the bottom of the pit.

The sutural borders present a prominent ridge, very rugose, with deep paired holes on either side of ridge, excepting the sutures separating the four posterior median plates which are well defined, but do not show raised edge or holes.

The outline of the shield is not as circular as in *E. petesatus*, and the border is more distinctly emarginated at the junction of the first and the second rows. The plates in the first row, also the median plates of the second row, in the present species are smaller than in *E. petesatus*, while the four posterior median plates are relatively larger.

The teeth differ from those of *E. petesatus*, especially in the anterior part of the jaw. The first molar is rather large, of elliptical contour, though the grinding surface is broken away, set obliquely to the dental series so that the anterior teeth of the two rows approach each other more closely than any of the following teeth. M^2 is larger, less elliptical, and obscurely trilobate, only one internal groove being prominent, with faint indication of posterior internal and external grooves. M^3 is much larger and more distinctly trilobate internally. M^4 is distinctly trilobate, the lobes separated by deep sulci; the anterior lobe in each tooth showing a groove on the anterior face near the external border. M^{5-8} are of the same pattern as M^4.

Most of the sutures are obliterated, so that little can be said of the cranial bones or of their proportions. The cranium is broad and depressed. The forehead is flattened and very wide, ending in a distinct postorbital process. The rostrum is very broad at the base, narrowing rapidly to the narial opening. The muzzle is heart-shaped. The zygomatic arch extends out widely from the skull and is very deep, with

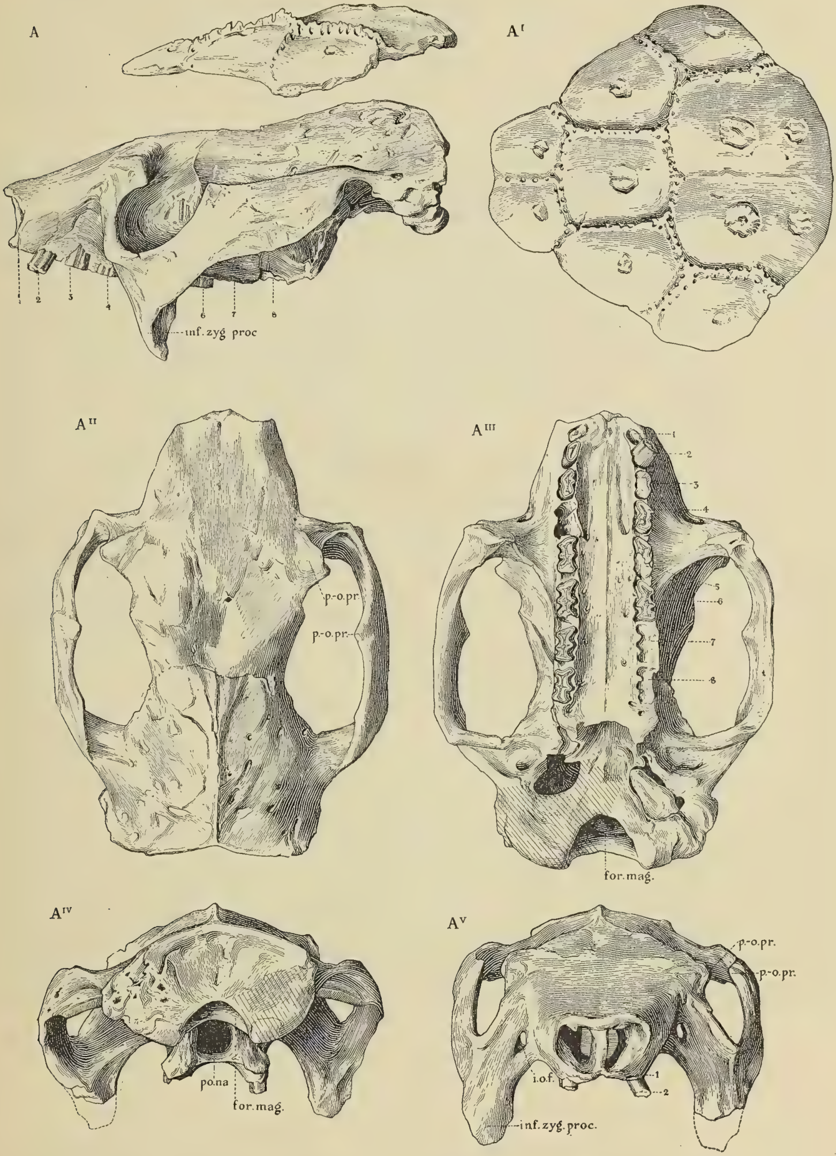


Fig. 1. *Eucinepeltus complicatus.* Type skull and casque. (No. 9248.) $\times \frac{1}{3}$.

prominent postorbital process. The descending process is triangular at the base. The parietals are very rugose, pitted with large foramina, gently convex transversely and longitudinally. The sagittal crest is prominent. The lambdoidal

Fig. 2. *Eucinepeltus complicatus.* Type casque. (No. 9248.) $\times \frac{3}{4}$.

crest extends out over the occipital plane in a heavy ridge, curving in to join the sagittal crest. The occiput is about half as high as wide; deeply incised for foramen magnum. The bony palate is perforated by numerous large foramina,

with a large foramen opposite the posterior of M^4. This foramen leads into a deep canal, extending forward nearly to the premaxillary. The palate is straighter than in *Propalæohoplophorus australis*, and forms with the superior line of the skull a more acute angle than in the last named genus.

Measurements.

Cephalic shield:	length in median line	130 mm.
" "	greatest width	133

Teeth.

M^1	Length	8 mm.	width	4 mm.
M^2	"	9	"	5
M^3	"	12	"	6.6
M^4	"	13	"	7
M^5	"	15	"	7
M^6	"	15	"	7.8
M^7	"	14.4	"	7.8
M^8	"	14	"	7.8

Upper dental series, length	109 mm.
Skull, extreme length	176
" length of median basal line	156
" " occ. condyle to anterior end of premaxillary	175
Cranium, length to anterior rim of orbit	125
" width behind zygomatic arches	102
Skull, maximum width over zygomatic arches	135
Occiput, height vertically	48
" width	89
Zygoma, extreme length inside	77
" maximum vertical diameter	28
" length of descending process	45
" breadth " "	20.5
Palate, length in median line	117
" width at M^1	14
" " at M^8	25
Rostrum, length	43
" width at base	63
" " at anterior end	41
Cranium, width at postorbital constriction	49
Face, length	53
Forehead, width across postorbital process	91

Article XII.—ORNITHOLESTES HERMANNI, A NEW COMPSOGNATHOID DINOSAUR FROM THE UPPER JURASSIC.

By Henry Fairfield Osborn.

The type skeleton (Amer. Mus. Coll. No. 619) of this remarkable animal was discovered at Bone Cabin Quarry, near Medicine Bow, Wyoming, by the American Museum Expedition of 1900. It was removed and transported to the Museum with the greatest care, and worked out, restored, and mounted under the direction of the head preparator, Mr. Adam Hermann, in recognition of whose many services to vertebrate palæontology the species is named.

The material embraces: the skull; 45 vertebræ, including 3 cervicals, 11 dorsals, a complete sacrum, 27 caudals; the complete pelvic girdle; representative portions of both fore and hind limbs,—all belonging to one individual; our knowledge of the manus is chiefly derived from another specimen (Amer. Mus. Coll. No. 587).

Principal Characters.

The entire length of the skull and vertebral column as restored is 2.22 m. (7 ft. 3½ in.); the height at the pelvis is .56 m. (22 in.).

The vertebral formula, except in the sacrum, is still undetermined.

The most distinctive feature is the narrowing of the manus and the great elongation (.172 m.) of the metapodials and phalanges of the second digit, suggesting the rapid grasping power of agile and delicate prey. This feature, combined with the prehensile character of the somewhat enlarged anterior teeth, the extreme lightness of the skeleton, the cursorial structure of the hind limbs, the balancing power of the tail, suggest the hypothesis that the animal may have been adapted to the pursuit of the Jurassic birds; in allusion to this supposed habit the genus may be named *Ornitholestes*, or 'bird robber,' as suggested by Dr. Theodore Gill.

A possible objection to this hypothesis is that the teeth, while distinctively prehensile, are not so serrate or trenchant as in *Cœlurus*. They are, however, quite as sharp as in the varanoid and other lizards which are known to capture and feed upon small birds.

The premaxillary contains 4 teeth, the most anterior of which is the largest tooth in the upper jaw. The maxillary retains 10 teeth, of which the fifth is the largest. In the dentary are 12 teeth. In both jaws the teeth occupy a rather short space, a little more than one third the entire length of the skull, and gradually decrease in size posteriorly. The premaxillary teeth are slightly worn on the posterior surface. There are two antorbital openings, a smaller within the maxillary, and a larger bounded posteriorly by the coalesced lachrymal and jugal. The orbits are very large, bounded posteriorly by the united postorbito-frontal, which connects by a slender bar with the squamosal. The depression of the quadrate extends the latero-temporal fenestra vertically. The jaw is relatively long and slender, with sessile coronoid process; the sutures have not been determined. The cervicals are gently opisthocœlous, the dorsals are amphicœlous, the posterior face being slightly more concave than the anterior; the caudals are gently amphicœlous. The neural arch only of the supposed fifth cervical is preserved. The supposed tenth and eleventh cervicals are moderately elongate, slightly opisthocœlous, with separate attachments for the capitulum on the anterior portion of the centrum, and for the tuberculum on the broad diapophysial expansion of the neural arch; the zygapophyses are large and the neurocentral suture is faintly indicated. In the supposed second dorsal or thirteenth presacral the capitulum is still borne on the centrum; behind the capitulum is a pit (paracœle), a feature also observed in the supposed fifth dorsal; the diapophysis is narrow; the head of the rib gradually rises to the junction between the centrum and neural arch, as in other dinosaurs. The four sacrals are firmly coalesced. The sacral ribs are still suturally distinct and attached chiefly at the sides of the centra, although the third sacral rib partially overlaps the

Fig. 1.—*Ornitholestes hermanni.* Type. Am. Mus. No. 619. × $\frac{1}{9}$. The unshaded areas indicate the portions restored.

posterior portion of the second centrum. The forked chevrons apparently begin at the posterior side of the third caudal, the chevrons being intervertebral; the hæmapophysial canal is apparently closed in the first chevron. The firmly coalesced caudal ribs of the anterior caudals are broad and backwardly directed. With the supposed thirteenth caudal there begins a gradual elongation of the zygapophyses, which reaches a great development between the sixteenth and twenty-fourth, the prezygapophyses being greatly elongated and partly encircling the somewhat smaller postzygapophyses of the preceding vertebræ. At the same time the chevrons become depressed, bifurcate in front, with a deep posterior keel.

Fig. 2.—*Ornitholestes hermanni.* Amer. Mus. No. 587. Palmar view of left manus. × ½.

The pelvic girdle is distinguished by the deep symphysial union of the pubes, the considerably more slender ischia, which are in contact distally and proximally exhibit two hooked processes; the ilium has a very broad pubic and narrow ischial peduncle, the pre- and post-acetabular portions of the depressed crest are subequal. A very distinctive feature of the postacetabular crest is the hollowing out and inferior expansion into a broad concave plate.

In the fore limb there was some question as to the determination of the ulna and radius. The humerus is longer than these elements, measuring .127 m. The few phalanges preserved enable us to associate with this animal a relatively complete manus belonging to another individual, in which the striking elongation of the second digit, the comparative slenderness of the third and the atrophy of the fourth can be clearly made out. The palmar view of the manus somewhat suggests that of the two-toed sloth. The terminal phalanges are elongate, recurved, and laterally compressed, with a distinct lateral claw-groove. The some-

what crushed femur (.207 m.) is much longer than the humerus and somewhat longer than the tibia (.159 m.). The pes has the typical tridactyl arrangement, the phalanges being more rounded and less decidedly curved than those of the manus; the median metatarsal measures .117 m.

Fig. 3.—*Ornitholestes hermanni.* Amer. Mus. No. 587. × ½. Left manus.

Generic and Specific Characters.

Skull with two antorbital openings; four premaxillary and ten maxillary teeth, non-serrate; twelve dentary teeth. Four coalesced sacrals. Mid- and posterior-caudal vertebræ with greatly elongate zygapophyses; manus narrow with greatly elongate digits, second digit of manus enlarged, fourth digit vestigial, fifth digit wanting.

Affinities.

The affinities of the animal are evidently with the light-limbed, slender-jawed group of Theropoda, for which the subordinal name Compsognatha Huxley will probably be found applicable, as distinguished from the large Megalosauria. The exceptional rod-like elongation of the pre- and postzygapophyses in the mid- and posterior caudals strongly suggests affinity to *Ornithomimus* of the Upper Cretaceous. *Ornitholestes*, however, is a much less specialized form, lacking the peculiar compression of metatarsal III which characterizes the Cretaceous genus. It is distinguished from the contemporary *Cœlurus* by the non-serration of the teeth, by the relatively short cervical vertebræ, by the less extreme hollowness of all the vertebræ. From the contemporary *Hallopus* it is distinguished by the less elongate character of the metatarsals. Comparison with smaller foreign Wealden

dinosaurs also serves to show its distinctness. The sacrum differs from that of *Aristosuchus* in the possession of four primary sacral ribs. The elongation of the second digit of the manus resembles that in *Archæopteryx*, but was evidently for a different purpose.

Article XIII.—A NEW THREE-TOED HORSE.

By J. W. Gidley.

The Expedition of 1902, sent out by Prof. Henry F. Osborn to explore the Miocene exposures in South Dakota, had the good fortune to obtain, besides other material, a complete skeleton of a large three-toed horse (Amer. Mus. Coll. No. 9815), associated with incomplete skeletons of five other individuals, undoubtedly of the same species.

This splendid specimen, which represents an undescribed genus and species, was discovered by Mr. H. F. Wells, a member of the party, in the upper Miocene deposits on Little White River, near Rosebud Agency, South Dakota.

The characters presented, especially in the teeth, if interpreted according to former authors, would undoubtedly place the present species in the genus *Hipparion*. However, as indicated by a careful study of this new material, and of the abundant material of other Miocene horses in the American Museum collection, together with a comparison with specimens and descriptions of the European forms, it seems probable that the genus *Hipparion* is limited in distribution entirely to the Old World, and that the American species formerly referred to this genus should be placed in a group distinct from *Hipparion*.

Before describing the new skeleton, therefore, the writer wishes to point out the chief characters which distinguish the Old World from the New World forms.

The characters common to both groups are as follows: (1) Column of protocone of the upper molariform teeth entirely surrounded by cement; (2) the lower molars of the milk dentition possess a median external basal tubercle; (3) each foot possesses three complete toes, the lateral ones being much reduced.

The characters which especially distinguish the true *Hipparion* are: (1) Protocone cylindric or subcylindric throughout the greater part of its length. (2) Enamel borders of the

fossettes of the upper molariform teeth very elaborately folded. (3) The middle portion of the external walls of the meta- and paracones is flat or slightly convex. (4) The external median tubercle in the lower milk molars is relatively high and circular in cross-section.

The American group differs from *Hipparion* in the following characters: (1) The protocone is relatively larger and elliptical in cross-section, or with the outer wall flat to concave. (2) The enamel foldings are in general comparatively simple. (3) The external walls of the meta- and paracones are concave. (4) The external median tubercle of the lower milk molars is elliptical in cross-section and less prominent than in *Hipparion*. (5) The limbs and feet, so far as known, indicate a comparatively more slender construction of the long bones and especially longer proportions of the metapodials. There is also apparently a relatively greater reduction of the lateral digits in the American genus.

These characters, as stated above, have the more significance from the fact that nearly all the American species are Miocene, while those of the Old World are of Pliocene age. It will be seen that in the development of the protocone and the ectoloph in the upper teeth, and the proportions of the feet and limbs, the American species, though coming from an older formation, are more progressive than the Pliocene species of Europe; while in some other respects, especially the complicated foldings of enamel in the upper teeth, the Old World species are more progressive. The reasons for separating these two groups are further strengthened by the fact that there are apparently no species common to both hemispheres.

From the foregoing it seems apparent that a new term is necessary for the American species hitherto referred to *Hipparion*, and they may be distinguished by the name **Neohipparion.**

The following description is based on the complete skeleton above referred to and is named in honor of Mr. William C. Whitney, whose generosity made possible the expedition which secured this very valuable acquisition to the present knowledge of American fossil horses.

Neohipparion whitneyi, gen. et sp. nov.

Generic characters. — Protocone free, except at base, as in *Hipparion.* Protocone comparatively large and much expanded anteroposteriorly. Enamel foldings simple. The median external basal column present in the lower milk molars as in *Hipparion*, but much shorter and more expanded anteroposteriorly. Lateral digits much reduced.

Specific characters.—Size about equal to *Neohipparion occidentale*, but enamel foldings much more simple, even more simple than in *N. affine. N. whitneyi* further differs from *N. affine* in the much stronger development of the styles of the ectoloph. Protocone relatively large and very much elongated in cross-section anteroposteriorly. Outer wall of the protocone flat and slightly folded inward, as is usual in *Equus caballus.* Metapodials very long and slender. Lateral digits greatly reduced, their terminal phalanges not extending to the distal end of the first phalanx of the median digit.

Although the collected material representing the Miocene horses of America is very abundant, it is, for the most part, so fragmentary and the different parts of the skeleton so uncertainly associated that most of the species are known only from the teeth. Hence the present specimen, though not in the line of ancestry of any of the living horses, may serve as a standard for comparison of equal value with *Mesohippus bairdii*, so fully described by Scott,[1] and may be described in detail as follows:

I. The Dentition.

Dental formula I.$\frac{3}{3}$, C.$\frac{1}{1}$, P.$\frac{4}{3}$, M.$\frac{3}{3}$. In proportion to the other parts of the skeleton the teeth are very large compared with those of *Equus caballus.* The molars and premolars of both jaws are heavily cemented.

The Upper Jaw. — The tooth-crowns, though strongly hypsodont, are of moderate length. Incisors much shorter than in *Equus.* P^1 is placed well back, extending but little forward of the anterior lobe of p^2 to which it is closely appressed on the inner side. This position brings it in opposition with the anterior lobe of p_2 of the lower jaw.

The external styles of the molars and premolars are as

[1] Journal of Morphology, Vol. V, 1891, pp. 301–342.

strongly developed as in *Equus caballus* and there is no trace of the external median ribs of the meta- and paracones. These last two characters are apparently common to all the species of *Neohipparion* and may be of generic importance.

Though the teeth in the present specimen are worn just to the stage when they present the most complicated pattern of enamel folding, they are very simple in this respect.

The Lower Jaw. — The incisors, like those of the upper jaw, are only moderately long-crowned, and are all fully cupped. The external pair is smaller than the others. The first premolar (p_1) is entirely wanting. The molars and premolars show an advanced stage of progression in the greatly flattened external walls of the para- and hypoconids. The antero-external enamel fold of the protoconid, except in p_2, is strongly developed. The lower border of the jaw is very much curved.

The Milk Dentition. — There is no trace of p^1 in the milk series of one of the specimens, but another associated specimen possesses this tooth reduced to a mere vestige. In the upper molars the protocones are strongly developed and free as in the adult. They are elongated in cross-section, though not to the degree shown in the permanent series. The lower molars possess a little tubercle arising from the cingulum between the para- and hypoconids. This conule is much shorter than in the *Hipparion* of Europe, but broader antero-posteriorly, being elliptical in cross-section. The outer walls of the para- and hypoconules are flattened, but in less degree than in the permanent series.

II. The Skull.

There are many primitive characters observable in the skull, the most prominent of which are the vertical thickness, general shortness, and consequently the relatively large space occupied by the molar-premolar series. The orbit is placed well forward, its anterior border being above the posterior half of p^2. The anterior projection of the masseter ridge extends forward to the middle of m^1. The position of the infraorbital foramen is between p^3 and p^4. The facial pit is

broad and its borders are not clearly defined. The anterior palatal foramina are small and do not extend back of the canines. The anterior border of the posterior narial notch is opposite the middle of m^2. The vomer overlaps the anterior end of the basisphenoid.

Measurements of Teeth.

	Anteroposterior.	Transverse.
Diameters of p^1	9.5 mm.	7 mm.
" " p^2	29.5 "	23.5 "
" " p^3	25 "	25 "
" " p^4	25 "	25.5 "
" " m^1	22 "	23 "
" " m^2	24 "	23 "
" " m^3		

Total length of series	152 mm.
Width across external incisors	55 "
Anteroposterior diameter of protocone, p^2	8 mm.
" " " " p^3	9.5 "
" " " " p^4	10.5 "
" " " " m^1	9 "
" " " " m^2	9.5 "
" " " " m^3	10.5 "

	Anteroposterior.	Transverse.
Diameters of p_2	24 mm.	11.5 mm.
" " p_3	25 "	13 "
" " p_4	25 "	12 "
" " m_1	24 "	10 "
" " m_2	25.5 "	9.5 "
" " m_3	22 "	75 "

Milk dentition (Upper)

	Anteroposterior.	Transverse.
Diameters of dp^2	31.5 mm.	21.5 mm.
" " dp^3	26 "	21 "
" " dp^4	29 "	20 "

Skull Measurements.

Total length of skull	378 mm.
" " " palate	205 "
Width of palate between first molars	44 "
" " " at narrowest point	29 "
Length of diastema between canine and external incisor	20 "
" " " " external incisor and p^1	67.5 "
Greatest width of posterior nares	28 "
Width of skull	128 "
" " condyles	54 "

III. The Vertebral Column.

The vertebral column of the type specimen was found completely articulated, even to the tip of the tail, hence the formula can be given without a possibility of error. It is as follows: Cervicals, 7; dorsals, 18; lumbars, 6; sacrals, 6; caudals, 17 + (?) 1.

The *cervicals* are long and slender and are horse-like in general appearance. They resemble much more those of *Equus* than those of *Mesohippus*, but show some intermediate characters.

The *atlas* differs from *Equus* in the following characters: The exterior pair of anterior foramina observed in the atlas of the horse are not bridged over in *Neohipparion*, but are represented by open notches at the anterior borders of the transverse processes. The median ventral tubercle, for the attachment of the longus colli muscle, is very strongly developed.

The *axis* is comparatively longer and of less vertical thickness than in either *Mesohippus* or *Equus*. Compared with *Equus* the odontoid process is not so deeply spout-like, and is proportionately narrower. The anterior vertebral foramina are comparatively large, opening directly into the side of the neural canal, and are not directed forward as in *Equus*. In *Mesohippus* the foramen seems not to be inclosed, but is open anteriorly. The spine is divided posteriorly into two diverging ridges which, extending backward and downward, merge into the posterior zygapophyses on either side. In *Mesohippus* the spine is not divided posteriorly, but extends backward, ending in a strong high tubercle.

The *3rd*, *4th*, and *5th* cervicals, except for their greater comparative length and more delicately formed processes, differ but little from those of the modern horse.

The ventral surface of the *6th* cervical is flat, turning downward laterally into the wing-like transverse processes, which are more strongly developed than in *Equus*. There is only a trace of the median keel, so well developed in both *Mesohippus* and *Equus*.

The spine of the *7th* cervical is comparatively higher than in *Equus*, but more reduced than in *Mesohippus*.

The spines of the anterior *dorsals* are long and slope backward at a greater angle than in *Equus*.

The spines of the *lumbar* vertebræ are comparatively high and narrow. The transverse processes of the third lumbar from the sacrum are comparatively long and do not articulate with those of the second lumbar from the sacrum.

The *ribs* are remarkably like those of the zebra in form, except the more posterior ones, which are proportionately longer and have a greater curvature.

The *sternum*, which is well preserved in the type specimen, is very characteristic. It is composed of six bony segments, as is usual in the horse, but the ventral keel, so highly developed in the living horses, is entirely wanting, except in the two anterior segments, and it is only weakly developed in these. The ventral surfaces of the third, fourth, and fifth sections are flat and are widest transversely. The xiphisternum is the largest of the series. The anterior portion of the ventral surface is broad, concave, becoming narrower posteriorly where the edges turn upward, making the posterior third of the ventral surface convex.

The *cartilaginous ribs* are composed mainly of spongy bone as in the horse, hence are preserved in the type specimen.

IV. The Fore Limb.

The *scapula* is distinguished from *Equus* by: (1) relatively narrow prespinous fossa; (2) the narrowness of the neck; (3) the prominent vertical ridge or thickening of the subscapular area beneath the postscapular border.

The *humerus* is widely distinguished from that of *Equus* by: (1) the depth and narrowness at the proximal and distal extremities; (2) the shallowness of the bicipital groove; (3) the absence of the groove in the lesser tuberosity; (4) the sharp definition of the grooves and convexities of the ulno-radial trochlea.

The *radius* is proportionately long and slender and, except

for modifications of the shaft, is much like that of *Equus*. The shaft of the radius, in its median portion, is concave behind, forming a sharp angle with the posterior border of the inner face.

The shaft of the *ulna* is continuous, but very much reduced, and firmly coalesced with the radius.

The *carpus* as a whole is more rounded in contour, and the transverse diameter is proportionately less than in *Equus*. The articulation of the scaphoid and magnum is peculiar. On the distal face of the scaphoid the facets for the articulation of the trapezoid and magnum are in form and position practically the same as in *Equus*, except that the magnum facet extends further backward and curving downward ends in a conical tooth-like process, which in the flexed position of the carpus fits into a corresponding depression in the magnum. In *Equus* the scaphoid and magnum do not touch each other when the foot is fully flexed.

The convex portions of the radial facets of the scaphoid and lunar occupy a relatively larger part of their proximal surfaces than in *Equus*. The cuneiform is proportionately smaller than in either *Mesohippus* or *Equus*. The pisiform is short, thin, and broad, resembling that of *Equus* in proportions. The trapezium is very small and rudimentary, and articulates principally with the trapezoid, though there are two other small facets which indicate that the trapezium articulates slightly with the scaphoid proximally and with the rudimentary metacarpal I distally. The unciform is relatively high and narrow, and projects below the distal face of the magnum.

The *metacarpus* consists of one principal and two much reduced lateral members, metacarpals III, II, and IV, and two rudimentary bones representing metacarpals I and V. These rudimentary metacarpals are about equal in size and are reduced to mere nodules of bone, which articulate principally with the second and fourth metacarpals respectively. Metacarpals II and IV are nearly as much reduced in size as the splint bones in *Equus*. Their proximal ends and the greater part of their shafts are placed well behind metacarpal

III. Their shafts taper to very slender proportions, but expand again distally, forming articular ends which support small lateral toes. Compared with *Mesohippus* and *Equus*, metacarpal III is very long and slender. The distal end is keeled entirely around, but is not so strongly developed on the distal surface as in *Equus*. The lateral toes are much shorter than the median toe, their extreme points reaching only to about four fifths the length of the first phalanx of the latter. The terminal phalanx of the median toe, compared with that of *Equus*, is proportionately longer and more compressed laterally in front. The palmar surface is heart-shaped in outline, with the apex deeply cleft. The proximal end is moderately high. The articular facet is placed at about the same angle as in *Equus*. Two processes extend outward and backward, one on either side of the articular face. These processes are thin, with rounded edges, and each is perforated by an arterial foramen.

V. The Hind Limb.

The *femur* is slender and the shaft is relatively long. The second and third trochanters are placed relatively nearer the proximal end of the shaft than in either *Mesohippus* or *Equus*. The groove for the ligamentum patellæ is comparatively longer and narrower than in *Equus*. The *tibia* exceeds the femur in length, but in other respects is like that of *Equus*. The *fibula* is as much reduced as in *Equus*. The remnant of the distal end is entirely fused with the distal end of the tibia.

The *tarsus* is relatively deeper anteroposteriorly than in *Equus*, but is essentially the same in other proportions. The shallow, irregular pits are beginning to form on the broad, flat facets of the astragalus, navicular, cuneiforms, and the proximal end of metatarsal III, but are, for the most part, only indicated by slight depressions and roughened patches on the bone surface. In *Equus* these pits are deeper and their boundaries are well defined, though varying greatly in size and form in different individuals.

The *metatarsals* are very long and slender, metatarsal III equaling the femur in length. The lateral digits are reduced

in about the same proportion as those of the fore-foot. The phalanges are much like those of the fore-foot, except that the terminal phalanx of the third digit is somewhat smaller and comparatively narrower than that of the fore-foot.

VI. Pelvis.

The *pelvis* shows a marked stage of advancement. It differs in no essential way from that of *Equus*, the proportions throughout being about the same as in *Equus caballus.*

As the comparisons in the foregoing description have been mainly with *Mesohippus bairdii* and *Equus caballus*, it may prove instructive to give here a comparative table of measurements taken from skeletons representing the three genera, and tables showing comparative proportions. In the latter the Virginia deer is included.

COMPARATIVE SKELETAL PROPORTIONS.

DORSO-LUMBAR SERIES TAKEN AS STANDARD.

Mesohippus bairdii.

Length of skull and neck	.80
" " back	1.
" " fore limb	1.10
" " hind "	1.12

Neohipparion whitneyi.

Length of skull and neck	.95
" " back	1.
" " fore limb	1.16
" " hind "	1.10

Equus caballus.

Length of skull and neck	1.03
" " back	1.
" " fore limb	1.30
" " hind "	1.11

Virginia Deer.

Length of skull and neck	1.
" " back	1.
" " fore limb	1.46
" " hind "	1.39.

COMPARATIVE PROPORTIONS OF LIMBS.

Mesohippus bairdii.

Length of fore limb	Fore 1. limb.
" " humerus	.23
" " radius	.24
" " metacarpal III	.16

Neohipparion whitneyi.

Length of fore limb	1.
" " humerus	.19
" " radius	.24
" " metacarpal III	.21

Equus caballus.

Length of fore limb	1.
" " humerus	.21
" " radius	.22
" " metacarpal III	.16

Virginia Deer.

Length of fore limb	1.
" " humerus	.19
" " radius	.23
" " metacarpals	.22

Mesohippus bairdii.

Length of hind limb	Hind 1. limb.
" " femur	.34
" " tibia	.34
" " metatarsal III	.17

Neohipparion whitneyi.

Length of hind limb	1.
" " femur	.27
" " tibia	.31
" " metatarsal III	.27

Equus caballus.

Length of hind limb	1.
" " femur	.31
" " tibia	.28
" " metatarsal III	.21

Virginia Deer.

Length of hind limb	1.
" " femur	.27
" " tibia	.31
" " metatarsals	.26

COMPARATIVE SKELETAL MEASUREMENTS.

	Mesohippus bairdii.	*Neohipparion whitneyi.*	*Equus caballus.*
	mm.	mm.	mm.
Skeleton: Total length, premaxillaries to ischia	......	......	......
" height, spine of 3d dorsal	460	......	1600
" breadth across ilia	135	290	620
Axial Skeleton: Skull, incisors to occipital condyles	175	378	638
" transverse, zygomatic arches	80	130	205
Vertebral column, 30 presacral vertebræ	645	1280[1]	1961
7 cervicals, total	195	446	686
midcervical centrum	30	80	135
18 dorsals, total	280	605[2]	911
4th dorsal, centrum	20	32	50
" " height of spine	53	135	250
7 lumbars, total	170	240[3]	364
2d lumbar centrum	23	40	58
6 sacrals, total	100	170	230[5]
caudals, total	?	325	650
Ribs, 5th, length, outer measurement	175	285	400
" 8th, " " "	190	365[4]	638
" 13th " " "	135	350	655
" 17th " " "	......	252	490
Appendicular Skeleton: Hind limb, total length	506	950	1416
Femur, total length	170	255	435
" circumference of shaft	55	100	215
Tibia, total length	170	290	400
" circumference of shaft	50	90	180
Pes, os calcis to Dig. III, Ph. 3	190	460	660
" transverse, tarsals	20	30	82
" anteroposterior, tarsals	22	34	70
Metatarsal III, total length	98	255	300
" " circumference of shaft	32	70	132
Fore limb, total length	498	1010	1660
Scapula, length	130	250	450
" greatest width	80	128	250
Humerus, total length	115	190	350
" circumference of shaft	47	85	190
Radius, total length	122	245	375
" circumference of shaft	38	80	165
Ulna, total length	157	300	490
Manus, lunar to Dig. III, Ph. 3	130	355	513
" transverse, carpals	19	40	88
" anteroposterior, carpals	15	30	55
Metacarpal III, total length	80	215	263

[1] Thirty-one presacral vertebræ. [2] Eighteen dorsals. [3] Six lumbars. [4] Seventh rib. [5] Five sacrals.

Article XIV. — ON TWO SPECIES OF PLATYGONUS FROM THE PLIOCENE OF TEXAS.

By J. W. Gidley.

Among the very interesting fossils obtained by the American Museum expedition of 1901 from the Blanco beds, are two specimens of peccaries. Both are referable to the genus *Platygonus*, but represent two distinct species. One is probably referable to *P. bicalcaratus* Cope, but the other is clearly distinct from any described species. Both specimens consist of upper teeth unassociated with those of the lower series.

Platygonus bicalaratus *Cope.*[1]

This species was founded on a posterior portion of a molar, m_3 of the lower series. Unfortunately there were no characteristic portions of the upper teeth associated with the type, hence the upper dentition of *P. bicalcaratus* is not known. As shown by Cope's figures, the crests of the lower teeth are

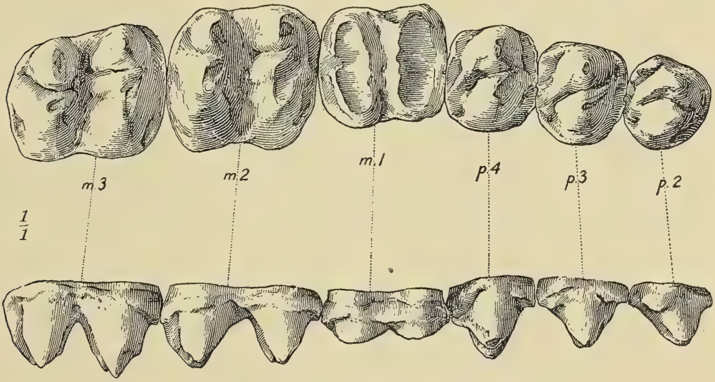


Fig. 1.—*Platygonus bicalcaratus ?* Cope. Right upper molar series. Amer. Mus. No. 10701. × 1/1.

very high, and the conids forming them are subequal. These characters, together with the agreement of size, have led the writer to refer provisionally the present specimen

[1] Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), pp. 68–70, Pl. XIII, fig. 5.

(No. 10701 Coll. Am. Museum, Fig. 1) to Cope's species, *P. bicalcaratus*, from the same beds. Although the teeth present the generic characters of *Platygonus* they differ strikingly from any species hitherto described in which the upper teeth are known.

The chief distinguishing characters are as follows: (1) The posterior and anterior crests of the molars are high and completely divided by the cross valley. (2) The cones forming the crests are comparatively wide apart at their summits; thus when they become a little worn the upper molars of this species present very much the appearance of the lower molars of the tapir. (3) The posterior heel in m^3 is entirely wanting.

Measurements.

		Anteroposterior.		Transverse.	
Diameters,	p^2	11	mm.	12	mm.
"	p^3	12	"	13	"
"	p^4	12	"	14	"
"	m^1	16.5	"	15	"
"	m^2	19.5	"	17.5	"
"	m^3	20	"	16	"

Platygonus texanus, sp. nov.

The second species, hitherto undescribed, is represented by the type, a palate (No. 10702, Am. Mus. Coll., Figs. 2 and 5),

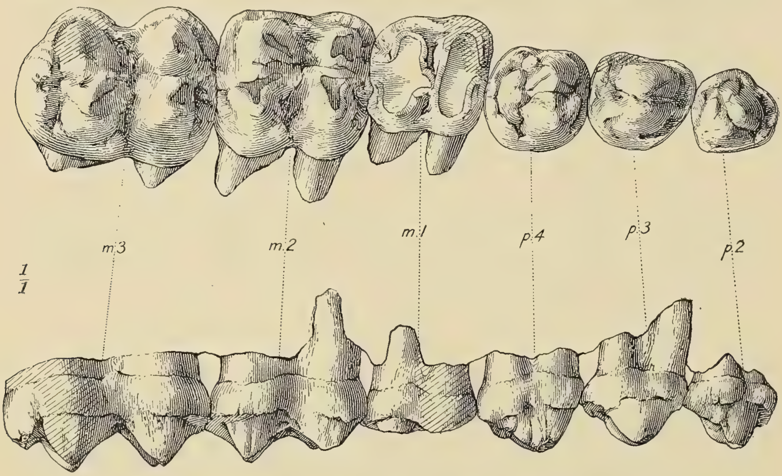


Fig. 2.—*Platygonus texanus.* Type. Amer. Mus. No. 10702. × ½.

containing the complete upper molar-premolar series, parts of the alveoli of the canines and incisors, and a portion of the upper anterior part of the skull.

Though coming from a later horizon,[1] the somewhat primitive quadritubercular character of the molars suggests in this species a close relationship to *P. rex* Marsh.[2] However, comparing it with a cast of Marsh's type, which the writer has at hand, the following differences are very clearly shown: (1) The four principal cusps of the molars are proportionally shorter. (2) The cusps are subequal in the anterior and pos-

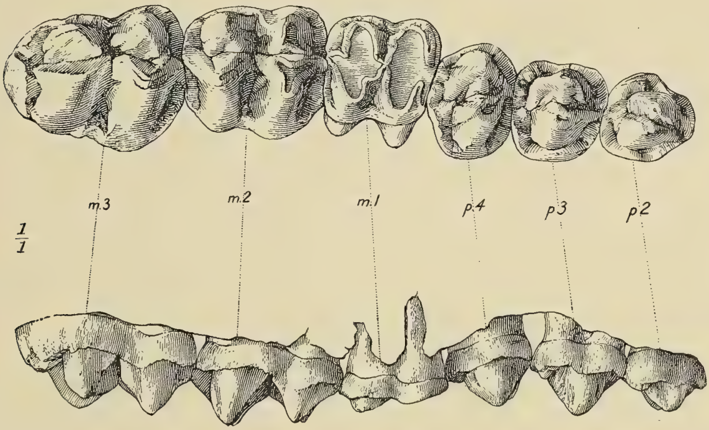


Fig. 3.—*Platygonus vetus.* Leidy. Amer. Mus. No. 2724. × 1/1.

terior pairs, and are comparatively wide apart at their summits. In *P. rex* the cusps of the outer side of the molars are perceptibly higher than those of the inner side. (3) The posterior heel of m^3 is much more strongly developed. It is very weakly represented in *P. rex.* (4) The size of the molars indicates a species larger than *P. rex.*

Compared with *P. vetus* Leidy (Figs. 3 and 4) the chief distinctions are as follows: (1) The cones of both the molars and premolars are proportionally lower and, in the molars, more

[1] The type locality of *Platygonus rex* Marsh is eastern Oregon. Marsh gives the horizon as Pliocene, but it is almost certainly Upper Miocene.

[2] Am. Jour. Sci. (3) xlviii, 1894, p. 273.

simple. (2) The molars are proportionally wider transversely, especially at the summits of the cones. (3) The posterior heel of m^3 is wider transversely, and is more dis-

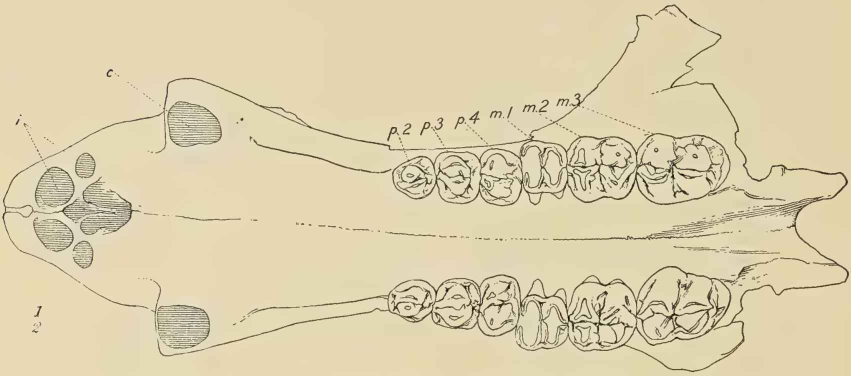


Fig. 4.—*Platygonus vetus* Leidy. Amer. Mus. No. 2724. × ½.

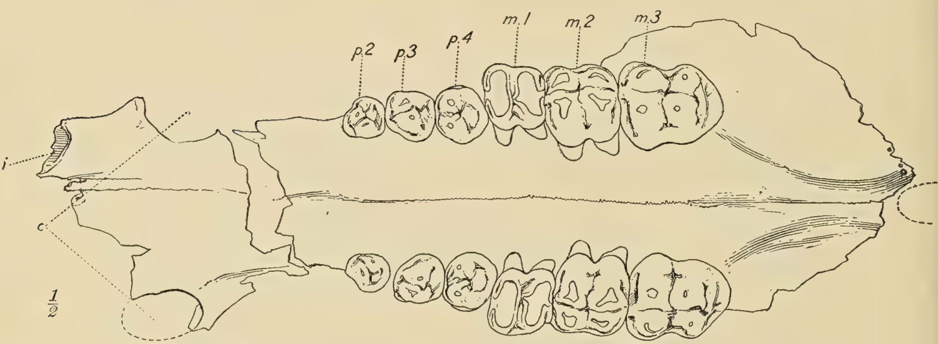


Fig. 5.—*Platygonus texanus*. Type. Amer. Mus. No. 10702. × ½.

tinctly separated by a cross valley from the posterior crest of the tooth. (4) The canine is proportionally much thicker anteroposteriorly than in *P. vetus*, as indicated by the alveolus. (5) The backward extension of the palatines is much greater than in any species in which this character is known, the anterior border of the palatal notch being situated nearly three times farther back of the posterior molars than in *P. rex*.

Measurements of Type.

		Anteroposterior.	Transverse.
Diameters,	p^2	11.5 mm.	10.5 mm.
"	p^3	13.5 "	12 "
"	p^4	14 "	14 "
"	m^1	17.5 "	15.5 "
"	m^2	20 "	20 "
"	m^3	25.5 "	21.5 "
Total length of series			101 mm.
Position of palatal notch back of posterior molars			48 mm.

Measurements of two upper molars of Platygonus rex *Marsh.*

		Anteroposterior.	Transverse.
Diameters,	m^2	19 mm.	16 mm.
"	m^3	21 "	18 "

(These measurements are taken from Marsh's figures and confirmed by the measurements of the cast.)

Article XV.—NOTICE OF SIX NEW SPECIES OF UNIOS FROM THE LARAMIE GROUP.

By R. P. Whitfield.

Plates XXXVIII–XL.

Among the collections brought in from the western portion of the country during the past season (1902), by Mr. Barnum Brown, there was a considerable amount of material from the Laramie group in Montana and adjoining territory. Most of this material was from a locality known as Snow Creek, on the Missouri River, about 130 miles northwest of Miles City, Montana, from a bed which was estimated by Mr. Brown as being 120 feet above the Pierre Shales. The fossils found here consist largely of Unios and other fresh-water forms, most of which are well known Laramie fossils; but among them there are a few Unios that are not recognizable as belonging to known species. They are pretty well defined forms, and it has been thought desirable to publish them as new, together with a list of the recognized species which accompany them. The fossils were found imbedded in a fine-grained gray clay, and are extremely friable and difficult of extraction, so much so, that it has been nearly impossible to free any of them from the matrix without an almost complete exfoliation and breaking up of the shell; only a few of them are sufficiently well preserved and perfect enough for illustration.

The following six species have been with difficulty illustrated by photography, so as to leave little or no doubt of their specific characters.

Unio æsopiformis, n. sp.

Plate XXXVIII, Figs. 1–5.

Shell of medium size, transversely ovate, largest at a point opposite the beaks, which are situated pretty well forward. Shell surface marked by a line of strong nodes extending from the beaks to the base of the shell behind the middle of the length, also by a slight sulcus just behind the line of nodes. Posterior cardinal slope somewhat

abrupt, forming an angular ridge along the umbonal slope from the beak backward, dying out behind the middle length. Sometimes a second faint ridge is seen between this and the border of the shell. Internally, the left valve, when not water-worn, has strong prominent cardinal teeth, and very prominent laterals with a deep groove, and the crest of the principal ridge is slightly crenulated. Muscular imprints deep and rugose. Pallial line strongly marked.

This species is very closely related to *Unio æsopus* Green in its general features, and even in the internal characters. But the oblique sulcus behind the line of nodes is not nearly so marked, and the nodes themselves are single bulgings of the shell substance, and do not have that flowing droplike feature of protrusion characteristic of the nodes of that species; nor does *U. æsopus* possess the angular carinations of the cardinal border possessed by this. Its extremely close resemblance to that species has suggested the new specific name, for the purpose of designating its probable relationship.

There are two distinct forms of the species recognized in the series; perhaps representing sexual differences. The second form is much narrower between the hinge and basal margin, and has a somewhat more distinct sulcus.

Unio verrucosiformis, n. sp.

Plate XL, Fig. 10.

Shell of nearly medium size, circular in outline, compressed-convex or subdiscoid on the surface, marked with a line of obtuse nodes from the nearly central beak to the basal margin, each node giving origin to a strong ridge passing obliquely downward and backward to the posterior margin, very nearly at an angle of forty-five degrees. Anterior half of the shell smooth or marked only by coarse lines of growth.

The species is represented only by a single imperfect right valve, the interior of which is so badly preserved as to be useless for illustration. The cardinal teeth, however, show evidence of having been very strong, the muscular imprints deep, and the pallial line anteriorly very strongly marked, as the shell has been quite thick.

This species has much the general features of *U. verrucosa* Barnes (= *U. pustulosa* Lea ?), but is more nearly circular;

more extended in front, not at all alate behind, with the pustules and pustulose ridges entirely different.

Unio retusoides, n. sp.

Plate XXXVIII, Figs. 6 and 7; Plate XL, Figs. 1 and 2.

Shell quite small, obliquely circular or vertically ovate, strongly inflated, with strongly corrugated beaks directed forward. A comparatively strong, deep sulcus passes from the beaks along the posterior margin from behind the beaks to the posterior basal border, forming a strong emargination or constriction above the postero-basal angle. Surface of the shell smooth, except in the region of the corrugated beaks. Corrugations of the beaks proportionally deep, forming a series of V-shaped ridges. Interior of the valves marked by extremely strong, prominent, cardinal and lateral teeth, and deeply-marked muscular imprints. Cardinal tooth in the right valve divided into two or three parts by deep gashes. Lateral teeth strongly curved and directed downward at an acute angle.

The close resemblance between this little shell and *U. retusa* Lam. as it occurs in the rivers of the West, is truly remarkable, and shows the persistence of the features of these fresh-water types through the vicissitudes of the many geological changes of the region bordering the waters of their habitations. The features of this, and the two foregoing species, are remarkable instances of this retention of character. The only noticeable difference between this species and *U. retusa* Lam. is the absence of the corrugations on the beaks of the recent shells.

Unio browni, n. sp.

Plate XXXVIII, Figs. 8 and 9.

Shell rather below medium size, subtriangular in general outline, with a moderately sharply elevated and strong beak; much and deeply corrugated on the upper portions and anterior side, and apical portion of the cardinal slope. Cardinal margin abruptly declining, in fact vertical to the plane of the valve, and sharply angular on the ridge from the beak to the posterior basal angle; from which point the margin of the shell is strongly rounded throughout the base and anterior end. Surface of the shell, from the base of the apical corrugations over the entire surface, smooth, except the ordinary lines of growth which are gathered into irregular varices. Corrugations on the apical portions of the shell disc very strong and deep, forming a

series of V-shaped ridges which retain on each arm of the V faint traces of the opposite set, producing a wavy surface to the ridges like the crossing of opposite lines of waves on water. On the anterior side of the beak, and on the posterior slope, the corrugations are finer and more irregular.

In the interior, the left valve is strongly marked. It possesses a very prominent cardinal tooth which is divided longitudinally by three slight gashes, and many corrugations. Lateral tooth moderately prominent and finely corrugated vertically. Muscular scars large and deep.

The most prominent feature of this species is its triangular form and strongly corrugated umbo. The nearest described Laramie species is *Unio holmesiana* White, from which it differs materially in wanting the posterior ridges of that shell, and in the entirely different structure of the corrugations on the umbones. The nearest allied living species among the American Unios is perhaps *U. securis* Lea, to which it can be said to bear only a distant resemblance, differing from that in many respects, but most strongly in the deeply marked corrugations of the apical portion.

Named in honor of Mr. Barnum Brown of the Museum corps, who collected the entire series.

Unio percorrugata, n. sp.

Plate XL, Figs. 3–9.

Shell small, quadrate, attaining a transverse diameter of only one and one eighth inch in the largest and oldest appearing individuals in the collection, which are excessively thickened. In the young stages of the shells, the form is very slightly transverse, but decidedly quadrangular. In the middle and aged condition, they are still quadrangular, but less transverse, that is, height and width are more nearly equal. The surface in the young stage is very strongly corrugated, the corrugations extending over fully one half of the disc, and very deep; while the front half of the shell is smooth, or marked only by the growth lines.

The interior has strong prominent cardinal teeth and deep sockets. The lateral teeth strongly bent and somewhat curved. Muscular imprints strong and deep. In the young shell the lateral teeth are more slender and nearly at right angles to the height of the valve, or parallel to the cardinal margin. In the older specimens the cardinal tooth of the left valve is much cut up and intersected.

The quadrangular form and the strongly corrugated beak, which seldom disappears, even on old water-worn examples, will serve as distinguishing marks of the species.

Unio postbiplicata, n. sp.

Plate XXXIX, Figs. 1–11.

Shell below medium size, transversely elliptical or subovate, with small obscure beaks situated at, or a little less than one fourth of the shell's length from, the anterior extremity. Valves moderately convex with the beaks and cardinal margin somewhat enrolled so as to give a somewhat cylindrical form to the shell when the valves are in contact. General surface of the shell smooth, with but moderately-marked growth lines. On the enrolled beaks, the surface is distinctly undulated for some distance back from the hinge line, and the posterior cardinal slope on each valve is marked by two distinct diverging ridges, extending from the point of the beaks along the posterior umbonal region to a greater or less distance toward the postero-cardinal border; but often becoming obsolete at some distance between these points.

In the interior the shells are much thickened and often excessively heavy. The teeth are strong and prominent, and the muscular imprints deep and well marked, the cardinal tooth strongly striated and the laterals curved and slightly striated vertically.

The distinguishing features of the shell consist of the undulations of the beaks and the two diverging ridges on the posterior cardinal slope of each valve. I cannot find any described Laramie form of *Unio* that will require comparison with this species.

The species of Laramie fossils identified from the material brought from Snow Creek and associated with the forms described in the foregoing pages are as follows:

Unio aldrichi *White.*
" danæ *M. & H.*
" holmesiana *White.*
" vetusta *Meek.*
" cryptorhynchus *White.*
Sphærium planum *M. & H.*
Corbicula subelliptica *M. & H.*
Campeloma multilineata *M. & H.*
" vetula *M. & H.*
" producta *White.*
Cassiopella turricula *White.*
Vivipara plicapressa *White.*
Thaumastus limnæiformis *White.*
Bulinus rhomboideus *M. & H.*

Several as yet undeterminable forms of Unios and other shells are in the collection.

EXPLANATION OF PLATE XXXVIII.

Unio æsopiformis Whitf., page 483.

FIG. 1.—Left side view of a slightly crushed specimen.
FIG. 2.—Cardinal view of the same specimen as Fig. 1.
FIG. 3.—Outside view of an imperfect left valve.
FIG. 4.—Interior of the same.
FIG. 5.—Interior of a left valve of the narrow form of the species.

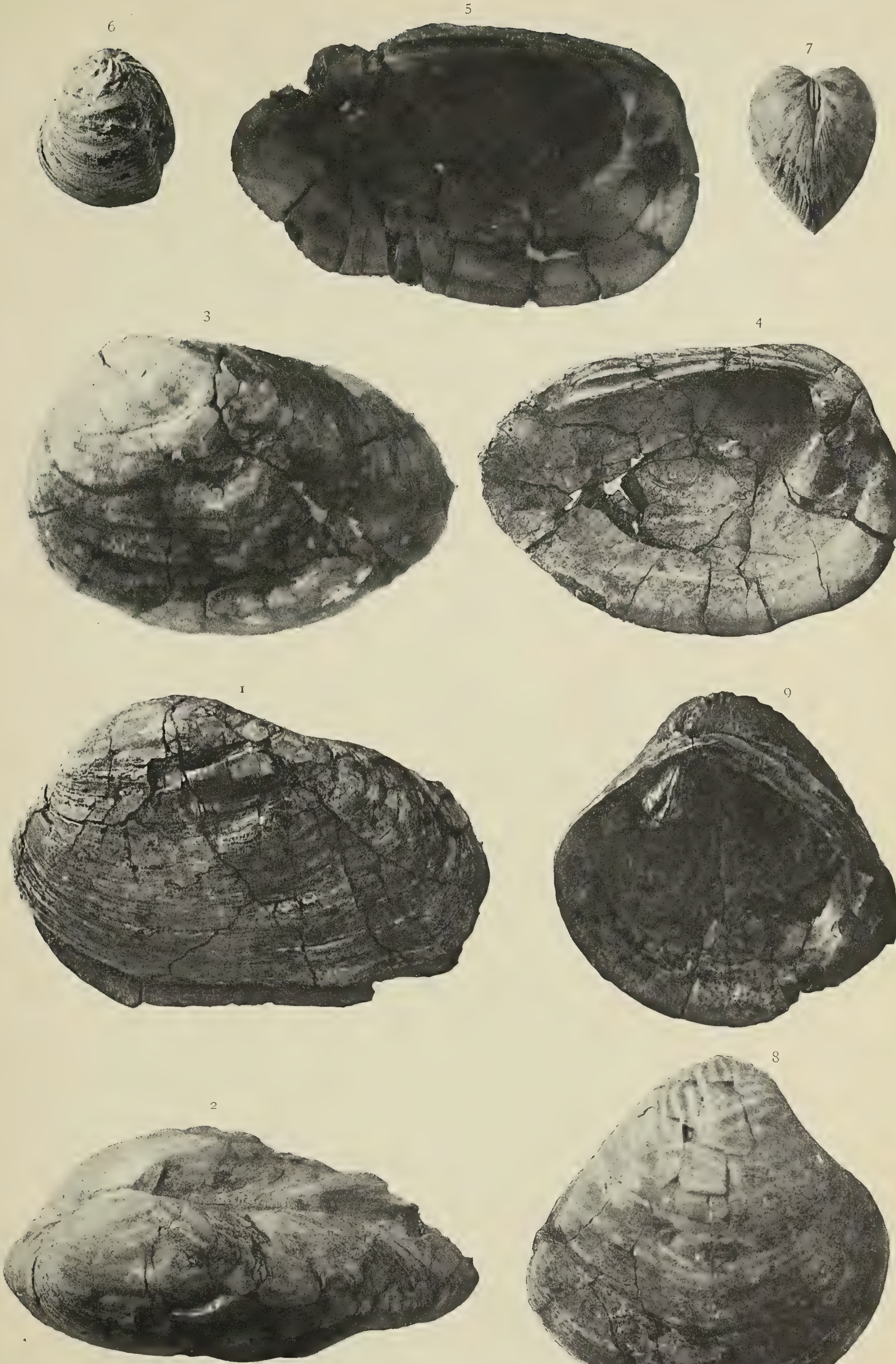
Unio retusoides Whitf., page 485.

FIG. 6.—Left side view of a very perfect specimen.
FIG. 7.—Posterior cardinal view of the same.

Unio browni Whitf., page 485.

FIG. 8.—Exterior view of the type specimen.
FIG. 9.—Interior of the same.

All figures natural size, and all from photographs.



LARAMIE UNIONIDÆ.

EXPLANATION OF PLATE XXXIX.

Unio postbiplicata Whitf., page 487.

FIGS. 1 and 2.—Exteriors of a right and a left valve of the usual form of the species.

FIGS. 3 and 4.—Views of a right and a left valve, old and thickened, the former much eroded at the beak.

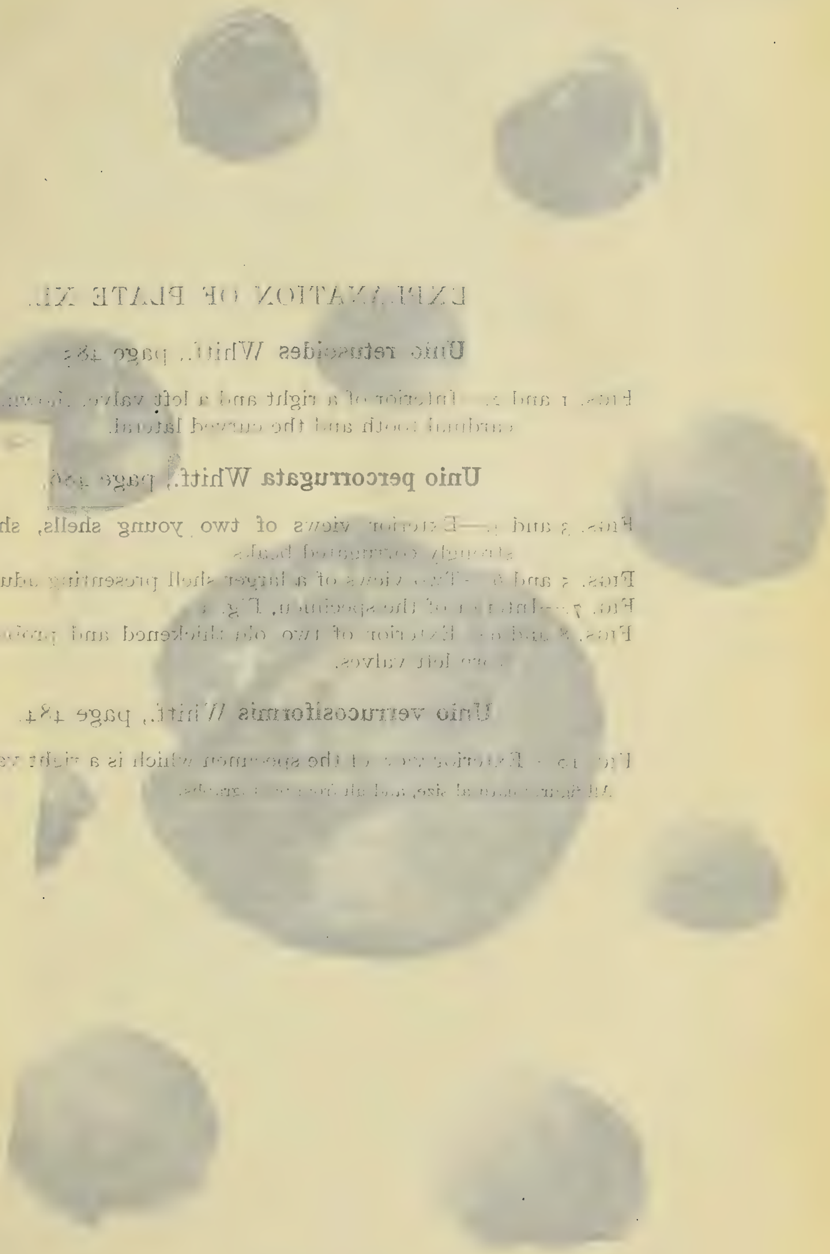
FIG. 5.—Exterior of a thinner left valve.

FIGS. 6 and 7.—Cardinal profile views, to show the undulations on the beaks, and the two diverging plications on the posterior umbonal slope.

FIGS. 8–11.—Interior views of the specimens, figures 1–4.

All figures natural size, and all from photographs.]

Laramie Unionidæ.



EXPLANATION OF PLATE XL.

Unio retusoides Whitf., page 485.

FIGS. 1 and 2.—Interior of a right and a left valve, showing the large cardinal tooth and the curved lateral.

Unio percorrugata Whitf., page 486.

FIGS. 3 and 4.—Exterior views of two young shells, showing the strongly corrugated beaks.

FIGS. 5 and 6.—Two views of a larger shell presenting adult features.

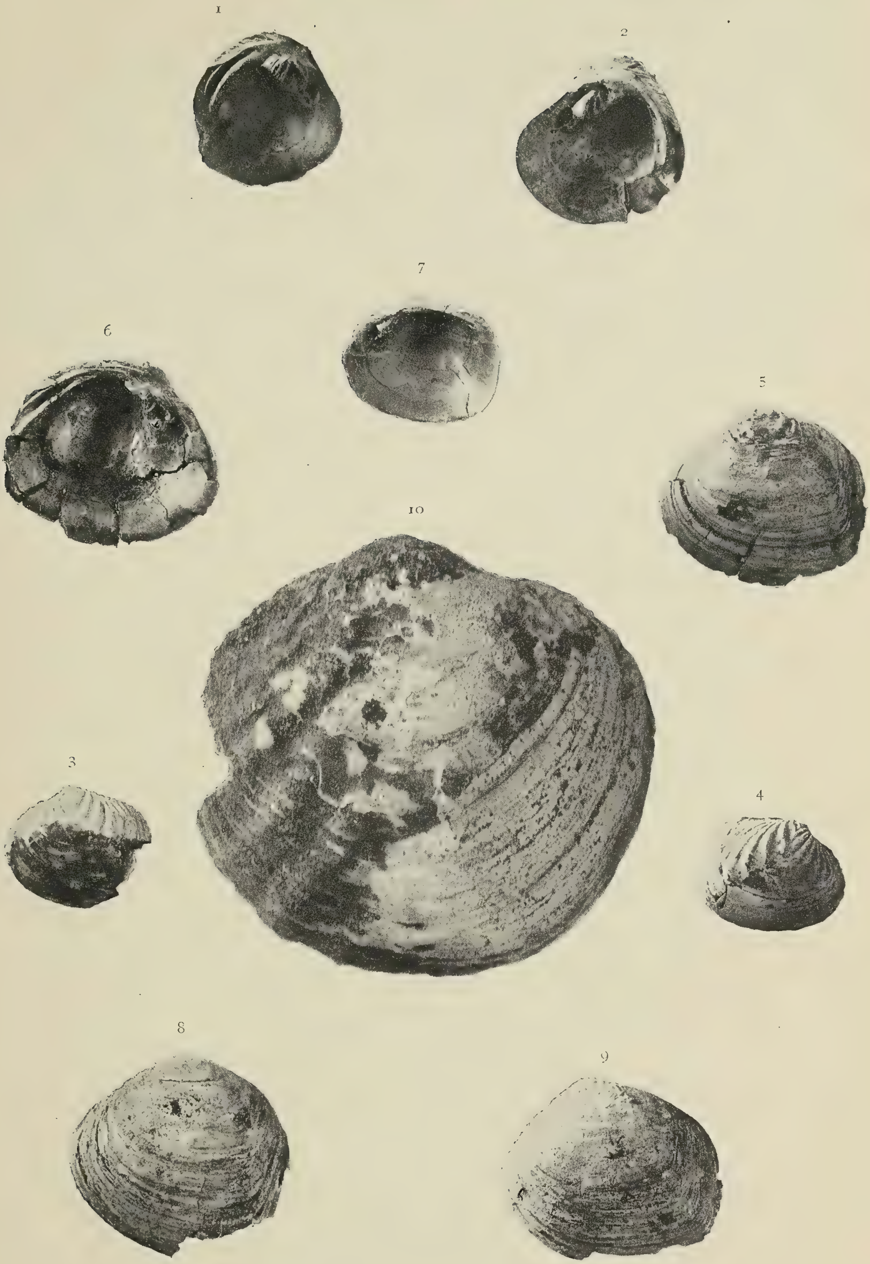
FIG. 7.—Interior of the specimen, Fig. 4.

FIGS. 8 and 9.—Exterior of two, old thickened and probably water-worn left valves.

Unio verrucosiformis Whitf., page 484.

FIG. 10.—Exterior view of the specimen which is a right valve.

All figures natural size, and all from photographs.



Laramie Unionidæ.

Article XVI.—OBSERVATIONS ON A REMARKABLE SPECIMEN OF HALYSITES AND DESCRIPTION OF A NEW SPECIES OF THE GENUS.

By R. P. Whitfield.

Plates XLI and XLII.

During the year 1879 the Museum authorities purchased a small collection of fossils (mostly western) from Mr. H. T. Woodman. Among them were several specimens of *Halysites*, one of which is the subject of the following observations.

It is remarkable in the first place for its size, being one of the largest known. It also presents on its upper side the original surface of the coral in about the condition it had while living in the Silurian seas. The surface presents seven botryoidal or convex bosses, characteristic of growing corals living at the present time, such as *Orbicella* and similar forms. In the variety of *Halysites* represented by the specimen the spaces between the lines of cells, or intermural spaces, are below the medium size, but not small enough to be classed under the variety known as *H. micropora*.

It is a noticeable feature that in the depressions between the several bosses forming the mass, the cell spaces differ remarkably in their form from those on the sides and on the surface of the elevations, where their form is that of the normal *Halysites catenulatus*. But in the places referred to, they are extremely elongated and compressed laterally, so that some of them are considerably over an inch long, while the two lines of polyp cells are almost in contact with each other. This feature obtains more or less generally low down on the sides of the bosses or in the channels between them, and only very sparingly further up on the sides or on the elevated portion of the boss.

Another noticeable feature of the cell walls is that the solid portion between the different cells is extended upward in a toothlike extension, producing along the crest of the ridge a sawlike or comblike character seldom seen on the ordinary specimens of the species; at least it is not seen on

any of the many specimens in the Museum's collection. There is often on silicified specimens a rounded knob-like feature produced by over-silicification, but it is entirely different from the feature mentioned above, and in examples from near Louisville, Ky., is seen as often on the lower as on the upper side of fragments.

The specimen in question was found in Jackson County, Iowa, together with many other fossils of the Niagara Group. Among them are two individual groups of a form which has for years been placed among specimens and labeled *Halysites agglomeratus* Hall, which are peculiar and remarkable as showing distinct radii in the polyp cells, a feature seldom or never seen in the typical form of the genus and one quite generally thought not to exist in the genus. These specimens, when closely compared with the typical series of *H. agglomeratus*, are found to differ in other important particulars as well as in the existence of cell rays. The cells are larger, the walls less thickened, the tabulæ thinner, flattened, instead of being strongly convex upward as in the types, and much more numerous. I therefore propose to separate it as a different species under the name *Halysites radiatus* with the following diagnosis.

Halysites radiatus, n. sp.

Plate XLII, Figs. 1 and 2.

Colony large (?), probably convex, at least showing distinctly diverging tubes as if rising from an initial center below. Polyp cells united laterally, forming on the surface lines or chains as in other species of the genus. Intermural spaces very irregular, owing to the tortuous windings of the lines of polyp cells. Polyp cells elliptical, about 1.5 mm. wide in the direction of the line of cells, and a little over 1 mm. in transverse diameter. Rays quite generally twelve in number, seldom extending quite to the center, but usually fully two-thirds of the distance. Tabulæ entire, flat, or nearly so, six or more in the space of 1 mm., but occasionally nearly twice as distant. External walls of the tubes transversely corrugated.

In only a single instance, on the specimens studied, a cell shows only eleven rays, but it occurs in a cell where the walls of surrounding cells have crowded this one out of shape. The rays are often recumbent on the surface of the tabulæ.

Geological position. Niagara Group. Jackson County, Iowa. Loose.

EXPLANATION OF PLATE XLI.

Halysites catenulatus Linn., page 489.

A photograph of specimen, ½ nat. size.

HALYSITES.

EXPLANATION OF PLATE XLII.

Halysites radiatus Whitf., page 490.

FIG. 1.—Side view, nat. size, of the type specimen, showing the large size of the tubes.

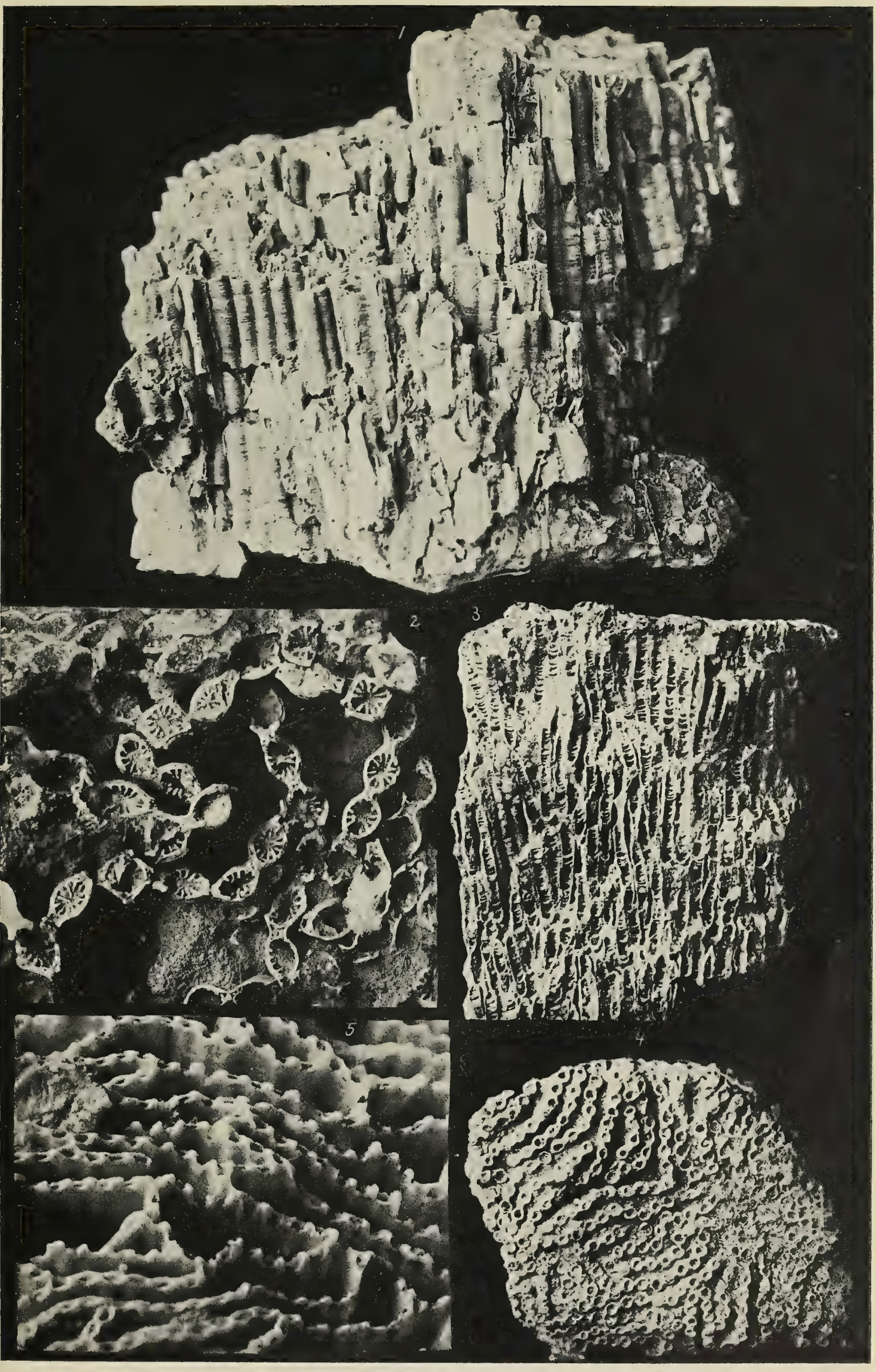
FIG. 2.—View of the cells showing rays. Enlarged to two diameters.

Halysites agglomeratus Hall.

FIGS. 3 and 4.—Side and top views of one of the types, nat. size.

Halysites catenulatus Linn.

FIG. 5.—Enlarged photographic view of a small spot of the specimen shown on Plate XLI, to show the projecting points between the cells. This feature exists over much of the surface where not abraded.



Halysites.

Article XVII.— GLYPTOTHERIUM TEXANUM, A NEW GLYPTODONT, FROM THE LOWER PLEISTOCENE OF TEXAS.

By Henry Fairfield Osborn.

Plate XLIII.

The existence of Glyptodonts in the United States was made known by Cope [1] in 1888 in his description of *Glyptodon petaliferus*, based on a single carapace scute or plate from the Lower Pleistocene Equus Beds of Texas; and by Leidy [2] in 1889 in his *Glyptodon septentrionalis*, based on carapace and caudal scutes from Florida; Leidy also described [3] and figured from Florida plates of the G. *petaliferus* type. The American Museum Expedition sent out by the writer, with the aid of the William C. Whitney Fund, under the leadership of Mr. J. W. Gidley, was fortunate in securing the nearly complete carapace, pelvis, sacrum, caudals, and complete tail armature of an individual in fine preservation. It proves to represent a new genus and species, combining characters of several of the South American forms of the Pleistocene and Miocene periods. The specimen was skillfully brought in by Mr. Gidley and prepared and mounted under the direction of Mr. Adam Hermann. The writer is especially indebted to Prof. W. B. Scott for pointing out several of the features in which *Glyptotherium* differs from the known South American genera. Also to Mr. W. K. Gregory for the preparation of the manuscript for the press.

The specific distinctions given below are derived by comparison of (1) the specimens referred by Leidy to *G. petaliferus* and of (2) Cope's description, which runs as follows: ". . . with the circumferential areas of the rosette but little smaller than the central one. The former are regularly pentagonal,

[1] Amer. Naturalist, Vol. XXII, 1888, p. 345.

[2] Proc. Acad. Nat. Sci. Phila., 1889, p. 97; and 'Description of Vertebrate Remains from the Peace Creek of Florida,' Trans. Wagner Free Inst. of Phila., Vol. II, 1889. p. 24.

[3] *Ibid.*, pl. iv, fig. 9; pl. vi, fig. 1.

the latter regularly hexagonal, and they are separated by well-defined grooves." Cope's type specimen is not available for comparison; it may prove that Cope's description and Leidy's reference are both misleading.

Glyptotherium texanum, gen. et sp. nov.

The *carapace* measures 1450 mm. (4 ft. 9 in.) along the dorsal curvature anteroposteriorly, and 1920 mm. (6 ft. 4 in.) from side to side; the tail armature is 620 mm. (about 2 ft. 1 in.) long, having a circumference proximally of 705 mm. The larger plates in the dorsal region measure 60 mm. in the longest diameter, which is oblique to the axial line of the carapace. The marginal plates may be estimated at 84, or 42 as counted on the more perfectly preserved left side. Eight of the posterolateral marginal plates are pointed or projecting; all the others have an even, gently convex, border. The central plates are quadrate in the lower portion of the shield, irregularly pentagonal and hexagonal in the upper, all being characterized by a large central circular area surrounded by from 7 to 12 smaller peripheral areas, all separated by grooves. From 35 to 36 transverse rows of these plates may be counted along the top of the carapace, and 34 at the side, practically the same number as in *Glyptodon clavipes* Owen.[1] The six anterolateral rows are firmly united, but the seventh to fifteenth are separated by deep grooves and admitted of some freedom of motion; these plates overlapped, the borders being bevelled. A similar freedom is observed in *Panocthus*.

The *tail armature* is composed of eighteen circles of plates, of which the anterior fifteen are arranged in paired rings and the posterior three are coalesced into a single triple piece or terminal cone. There are thus eight of the movable rings, of which the seven anterior are composed of two rows of simple flattened plates, and the eighth of a single row of elongate

[1] *Cf.* Lydekker, R., Contributions to a Knowledge of the Fossil Vertebrata of Argentina, Pt. II., pll. i–v. Paleontologia Argentina, III. La Plata, 1894.

plates with three pieces intercalated anteriorly. Behind these eight distinct rings is the terminal cone, composed of three rings of plates; of this coössified portion the anterior ring contains eight pieces with two anterolateral pieces; the mid-ring is composed of six pieces, and the terminal ring is irregularly composed of four pieces. Thus the tail comprises eight complete rings and a terminal cone, the same number as in *Glyptodon clavipes* as described by Lydekker. The rings gradually increase in length from 60 mm. anteroposterior measurement, and decrease in diameter from 230 to 183 mm. The terminal cone is laterally compressed, measuring 75 mm. transversely and 132 anteroposteriorly. The posterior borders of the ring plates are gently scalloped, not pointed as in *Glyptodon clavipes.*

Within the carapace and caudal rings were found one *sacrocaudal* and thirteen free *caudal vertebræ*, with an imperfectly developed fourteenth, and seven chevrons—all perfectly preserved. Of these vertebræ the posterior ten, as appears from measurement and from the deflected transverse processes, were fitted within the tail-sheath, there being thus a vertebra for each ring, while the anterior three articulated with the peculiar sacrocaudal vertebræ, in which the greatly elongated transverse processes or ribs extend outward to coössify with the posterior plates of the ischia. The first free caudal has a transverse diameter of 302 mm., and distinct lateral articulations as facets for the posterior borders of the last sacrocaudal and of the ischium; the neural laminæ are elevated, the pre- and postzygapophyses are elevated and vertically placed; the neural spine is low; caudals 2 and 3 were also well within the carapace, with transversely extended spines; in caudals 4–11 the transverse processes are deflected, downwardly and forwardly directed; the neural arches, zygapophyses, and spines diminish in distinctness. Caudals 12–13 lack all processes. A single *chevron* of the narrow type, similar to the most anterior chevron in *G. clavipes*, was found with the specimen; it measures 130 mm. vertically. Six stout chevrons with shallow, obtusely forked inferior processes, anteroposteriorly expanded distally, are placed beneath

caudals 5–11. These chevrons have an entirely different form from the deep, narrow chevrons in *G. clavipes*.

Both ossa innominata, as well as the entire dorso- and caudo-sacral complex, are preserved.

Generic and Specific Characters.

The hexagonal osseous plates of the carapace of this species resemble those figured by Leidy (*op. cit.*, pl. iv, fig. 9; pl. vi, fig. 1) as *G. petaliferus*, but differ specifically in: (1) the relatively large size of the central area; (2) the smaller size and irregular form of the peripheral areas; (3) the shallowness of the circular and radiating grooves.

As regards generic distinction, this animal is very primitive and simple in its tail structure, which strongly suggests that of *Propalæohoplophorus* and other Santa Cruz (Miocene) types, but it appears to show some degeneration in the sculpturing of the carapace plates, in which the central and marginal areas are not so sharply defined as in *G. petaliferus*, *Panocthus*, and other types. The imbricating lateral plates suggest those of *Panocthus*. The shallow caudal chevrons are rather like those of *Sclerocalyptus* (*Hoplophorus*) than the deep chevrons of *Glyptodon*. The general shape of the carapace is also rather like that of the *Sclerocalyptus* type than that of *Glyptodon*.

Glyptotherium texanum, Type.
With *Lysiurus unicinctus.* $\times \frac{1}{9}$.

Article XVIII.—WEST INDIAN SPONGE-INCRUSTING ACTINIANS.

By J. E. Duerden.

Plates XLIV–XLVII.

Among collections of sponges from the West Indies will usually be found one or more specimens on the surface of which are numbers of small, white, circular discs, altogether unlike the sponge in texture. The discs are either arranged singly, in a scattered manner, or are connected in chain-like rows, forming long or short colonies. Less frequently the incrustations are orange in color, and form short linear or irregular expansions. To the casual observer the white circular discs not infrequently suggest the coiled tubes of some *Spirobis*.

Many examples of sponges having such incrustations are to be seen in the collections of the American Museum of Natural History, the United States National Museum, and the British Museum. The photographic reproductions on Plates XLIV-XLVI are from specimens in the New York institution. The real nature of the organisms was apparently first determined by the West Indian naturalists, MM. Duchassaing and Michelotti ('50, '60, '66), who, having observed them in their living expanded condition, recognized them as zoanthid polyps. Several species have been described by these authors, and referred to very diverse zoanthean genera; among these is the peculiar genus *Bergia*, the systematic position of which has long been in doubt, and which has even been made the type of a family, Bergidæ. Owing to the very few external characters available for diagnostic purposes, and to the variable nature of the colonies, the determination of certain of the species is now somewhat difficult.[1]

In studies on the Jamaican Actiniaria ('98, '00) I described

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[1] Prof. J. P. McMurrich kindly informs me that among the type collections of Duchassaing and Michelotti, now in Turin, there are no representatives of sponge-incrusting actinians.

three species of actinians commensal on sponges, and by microscopic examination proved that they are all referable to the genus *Parazoanthus* of Haddon and Shackelton ('91, p. 563). With one exception, *P. swiftii*, I hesitated in identifying the Jamaican specimens with the meagre accounts which Duchassaing and Michelotti give of their species, awaiting the possibility of obtaining more material for comparison. Specimens collected later in the West Indies, as well as examples from the same area found in various museums, have now afforded the means for instituting a better comparison of all the sponge-incrusting forms. They demonstrate that in all probability they are referable to only three species, one of which is certainly the type species of the genus *Bergia*. In their distribution they range from the northern Bermudas and Bahamas to the Lesser Antilles, whence the original types were taken. Further, the species all belong to one genus, *Parazoanthus*, and thus the systematic position of the genus *Bergia* is finally settled.

Parazoanthus catenularis (*Duch.*) *Duerd.*

Plates XLIV and XLVII.

Alcyonium serpens Lamarck, Hist. Nat. des Anim. sans Vert., 2nd ed., Vol. II, p. 604

Bergia catenularis Duchassaing, 1850, p. — ; Duch. & Michl., 1860, p. 54, pl. viii, fig. 12; Duerden, 1898, p. 464.

Parazoanthus monostichus Duerden, 1900, p. 202, pl. x, fig. 14, pl. xiii, fig. 9.

Bergia via lactea Duch. & Michl., 1860, p. 54.

Duchassaing's original description of this species in 1850 was very brief, and his later account ('60), in collaboration with Michelotti, did not add much. It is made the type species of the genus *Bergia*, which Duchassaing and Michelotti ('60, p. 54) characterize as including very short polyps forming a chain-like incrustation on the surface of sponges, the polyps arising from one another by stolons (propogules), not from a common membrane, and originating from the upper or cephalic part of the polyp. The commensalism and cateni-

form habit was supposed to call for a distinct place among actinian genera. Hitherto the genus has not been subjected to reëxamination.

In subdividing the Zoanthacea, in 1868, Verrill recognized the three families Zoanthidæ, Bergidæ, and Orinidæ. The separation was based entirely upon external characteristics, the Bergidæ including forms "in which the stolons arise from the sides above the base." The family included only the genus *Bergia*, and, though founded upon such a trivial character as the place of origin of the connecting stolon, was accepted by Andres ('83) and by McMurrich ('89).

The characters given in the original diagnosis, however, are only specific, and altogether insufficient for family or even generic distinction, especially in the light of recent anatomical studies on actinians, where form and habit are found to count for comparatively little. Haddon and Shackleton ('91, p. 363), in their revision of the Zoantheæ, erected the genus *Parazoanthus* to include a number of incrusting zoanthids, defining it as follows: "Macrocnemic Zonatheæ, with a diffuse endodermal sphincter muscle. The body wall is incrusted. The ectoderm is continuous. Encircling sinus as well as ectodermal canals, lacunæ, and cell-islets in the mesoglœa. Diœcious. Polyps connected by thin cœnenchyme, rarely distinct." The salient characters are the macrocnemic arrangement of the mesenteries, and the presence of a diffuse endodermal sphincter muscle.

An anatomical investigation of the representatives of the genus *Bergia* shows that the polyps present all the important details given above, hence the genus now becomes merged in *Parazoanthus*, which includes a number of small incrusting zoanthids growing upon sponges, hydroids, shells of molluscs, etc.

The genus *Bergia* has hitherto included but two species—*B. catenularis* and *B. via lactea*, but an inspection of large numbers of specimens renders it very doubtful whether any specific separation can be maintained. The only specific characters for the first are that in the living state the polyps are a yellow brown, with 20–24 cylindrical tentacles pointed

at the apex, and of a clearer color than that of the disc. The figure given represents an upper view of four polyps connected by narrow stolons. Andres ('83, p. —) repeats the original description and takes the liberty of representing in a wood-cut the polyps as they may be supposed to appear if seen in side view; Delage and Hérouard ('01, p. 667) also repeat the figure of Andres. *Bergia via lactea* is distinguished by having larger polyps than the preceding, and disposed in an irregular manner; the color is also different, the disc and tentacles are violet instead of yellowish. Duchassaing and Michelotti identify *B. catenularis* with the *Alcyonium serpens* of Lamarck, though the characters given by the French author are scarcely sufficient to make certain which species was intended.

In a preliminary list of the Actiniaria of Jamaica ('98) I identified a small sponge-incrusting actinian as *B. catenularis*, but, in a fuller paper ('00), came to the conclusion that the safest course was to regard it as a distinct species, and named it *Parazoanthus monostichus*. The absence or small amount of cœnenchyme connecting the individual polyps in the specimens then available seemed to suggest a different species.

The larger quantity of material now accessible proves that the species varies greatly in its habit, according to age; and on the same sponge may be two fairly distinct types of growth which appear to combine in a satisfactory manner the two species of Duchassaing and Michelotti. Where the zoanthid colony is in active growth it forms long, narrow, chain-like rows of polyps, connected by a superficial stolon-like cœnenchyme; but in older colonies the rows are broken up into small groups of polyps, without much intervening cœnenchyme, or the polyps may be altogether isolated. In the latter stage the individual polyps are also larger and might be mistaken for the next species—*P. parasiticus;* but the polyps of this species are larger and are rarely arranged on the sponge in long rows. The variation in habit of the present species is well shown in the photographic reproduction on Plate XLIV. The new colonies in long chain-like rows are mainly toward the margin of the zoanthid growth. In the form first described by me as *P. monostichus* only the older

type of growth was present, not the more truly cateniform stage.

Recently I have collected sponges bearing living colonies of this species, and have been able to preserve them expanded and in good condition for study. The polyps when alive were nearly colorless or yellowish brown. None showed the violet color ascribed to *Bergia via lactea*, though such variations in color are not at all infrequent in actinians. A colony of four polyps, wholly separated from the sponge, is represented on Plate XLVII, and shows the actual relationships of the polyps and cœnenchyme. Normally the whole of the latter is embedded in the sponge, being exposed only on the upper surface; the actual appearance scarcely warrants the figure which Andres gives, based on Duchassaing and Michelotti's description. The capitular ridges vary from eight to twelve; and the tentacles are double these numbers.

Details of the anatomy are represented on Plate XLVII, and will serve to supplement those given in the account of the Jamaican Actiniaria ('00, pp. 202–206). The mesenteries, as shown in Fig. 2, are macrotypic, and are in eight pairs, but may increase somewhat beyond this.

No ectodermal sphincter is present; indeed, the columnar circular muscle as a whole is of the feeblest character, and the polyps do not readily retract and overfold. The possible absence of the sphincter should be added to the diagnosis of the genus. It is merely a detail, not of kind, but of comparative significance, to be associated with the smallness of the polyps. The species is undoubtedly closely related to the next, in which the sphincter is fairly well developed ('00, pl. xiv, fig. 4); its presence or absence does not call for generic separation. The same remark will probably apply to the absence of the ciliated bands or Flimmerstreifen from the mesenterial filaments in both this and the next species; they are present in closely related species where the polyps are larger.

Parazoanthus parasiticus (*Duch. & Michl.*) *Verr.*

Plate XLV.

Zoanthus parasiticus Duch. & Michl., 1860, p. 50, pl. viii, figs. 3, 4.
Parazoanthus separatus Duerden, 1900, p. 197, pl. x, figs. 12, 13; pl. xiii, fig. 8; pl. xiv, fig. 4.
Parazoanthus parasiticus Verrill, 1900, p. 560.

This is perhaps the most common of the sponge-incrusting actinians. If the synonymy above given be correct Verrill finds it frequently parasitic on the "glove sponge" (*Tuba* or *Spinosella vaginalis*) from the Bermudas; it is present on many specimens of the same sponge from the Bahamas now in the American Museum of Natural History; I have obtained it several times on various species of sponges around Jamaica, while Duchassaing and Michelotti secured their specimens from the Lesser Antilles.

When the account of *P. separatus* was published I had seen the species only in the retracted condition, and the walls of the polyps throughout were so thoroughly impregnated with sponge spicules that I could not see how it could possibly be identified with the *Zoanthus parasiticus* of Duchassaing and Michelotti, these authors stating that their species is a veritable *Zoanthus* with fleshy walls, not hardened by inclusions. I have since had living polyps under examination and find that when the column is fully expanded it appears practically devoid of incrustations, though a few spicules are aggregated towards the capitular margin. Duchassaing and Michelotti must have been referring to this appearance of the column in the expanded state, for when the same polyp is retracted the walls are thickly impregnated; the tissues are then firm and opaque white, due to the closeness of the inclusions, but on full expansion they are quite delicate and transparent to a degree probably not met with elsewhere among zoanthids. The specimens from the Bermudas which I have seen are certainly the same as the Jamaican forms, and I believe that Verrill's identification of them with *Zoanthus parasiticus* is correct.

A few external characters observed on the living expanded

polyp may be added to those given in previous accounts. The column can extend beyond the surface of the sponge as much as 4 mm. and is about 3 mm. in diameter; it is then clear or minutely granular according to the quantity of inclusions. The upper margin is often a dull white, the remainder a pale brown. The tentacles are short and tapering or digitiform, in two cycles, alternately large and small, about 24 in number, and are pale brown in color, containing but few Zoöxanthellæ.

Usually only the retracted column and an extremely narrow margin of cœnenchyme is seen at the surface of sponges, and generally the different polyps are wholly separated from one another. On some sponges, however, the polyps are seen connected with one another in rows, but the connecting cœnenchyme is embedded in the sponge and soon breaks down. This is well shown on the uppermost part of the right tube of the sponge on Plate XLV.

The retracted polyps vary a little in size, the diameter being from 2 to 3 mm., but no other characters have been found which would justify specific separation. Anatomically it differs from the previous species in having a well defined diffuse endodermal sphincter muscle ('00, pl. xiv, fig. 4).

Parazoanthus swiftii (*Duch. & Michl.*) *Duerd.*

Plate XLV.

Gemmaria swiftii Duch. & Michl., 1860, p. 55, pl. viii, figs. 17, 18; 1866, p. 138.

Polythoa (*str. s.*) *axinellæ* (pro parte) Andres, 1893, p. 331.

Palythoa swiftii Roule, 1900.

Parazoanthus swiftii Duerden, 1898*a*, p. 372, pl. xvii*a*, fig. 11; pl. xx, figs. 5, 6.

This species seems to occur less frequently in the West Indies than the other two. I have met with it only around Jamaica, while Duchassaing and Michelotti secured their types from St. Thomas.

It is an easily recognizable form, particularly in the living condition. The polyps are arranged a few in number on a

thin, narrow, linear or irregular cœnenchyme, or the cœnenchyme is somewhat expanded and two or three individuals may occur abreast. The colonies when alive are a bright orange yellow and stand out very conspicuously against the dark colored sponge with which they are commensal. Even at a depth of several feet in the water the color affords a great contrast, and on dried colonies kept for four or five years and now in the American Museum of Natural History it is still pronounced. Histological examination reveals that the coloration is due to an extraordinary abundance of bright yellow pigment granules throughout the ectoderm and endoderm.

The capitulum presents twelve serrations at the apex, and the tentacles are in two cycles of twelve each; the diameter of the expanded disc is 4 mm., and that of the column in retraction is 2 mm. Anatomically the sphincter muscle is well developed, and the mesenteries are in twelve pairs, macrocnemic in their arrangement. A fuller description occurs in 'Jamaican Actiniaria,' Part I.

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HUS CATENULARIS.

EXPLANATION OF PLATE XLIV.

PARAZOANTHUS CATENULARIS (Duch.) Duerd.

Colonies incrusting sponge (sp. ?) from the Bahamas. Towards the margin of the branches of the sponge the zoanthid colonies are in a more active state of growth, and are chain-like in appearance; elsewhere the chain character has been broken up and the polyps are in isolated groups. About $\frac{2}{3}$ natural size.

Parazoanthus catenularis.

EXPLANATION OF PLATE XLV.

PARAZOANTHUS PARASITICUS (Duch. & Michl.) Verr.

Colonies incrusting the "glove sponge," *Tuba* or *Spinosella vaginalis*, from the Bahamas. The actinian appears mainly as isolated white circular discs. About $\frac{4}{5}$ natural size.

Parazoanthus parasiticus.

EXPLANATION OF PLATE XLVI.

PARAZOANTHUS SWIFTII (Duch. & Michl.) Duerd.

Colonies incrusting a sponge, *Hircinea* (sp. ?), from Jamaica. About $\frac{4}{5}$ natural size.

Parazoanthus swiftii.

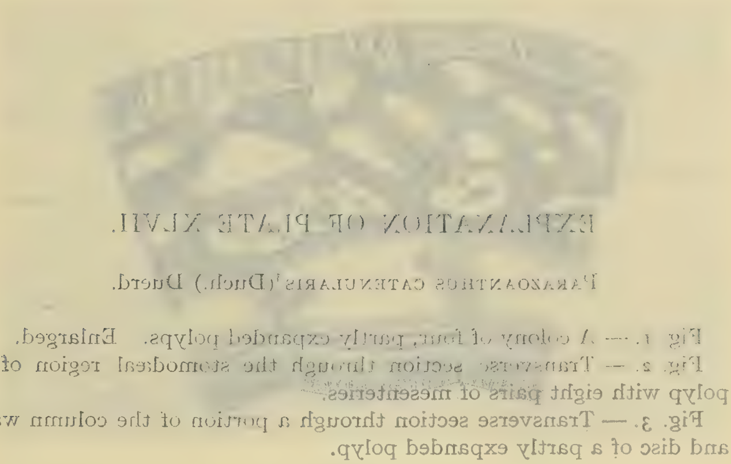


Fig. 2.

EXPLANATION OF PLATE XLVII.

PARAZOANTHUS CATENULARIS[1] (Duch.) Duerd.

Fig. 1. — A colony of four, partly expanded polyps. Enlarged.

Fig. 2. — Transverse section through the stomodæal region of a polyp with eight pairs of mesenteries.

Fig. 3. — Transverse section through a portion of the column wall and disc of a partly expanded polyp.

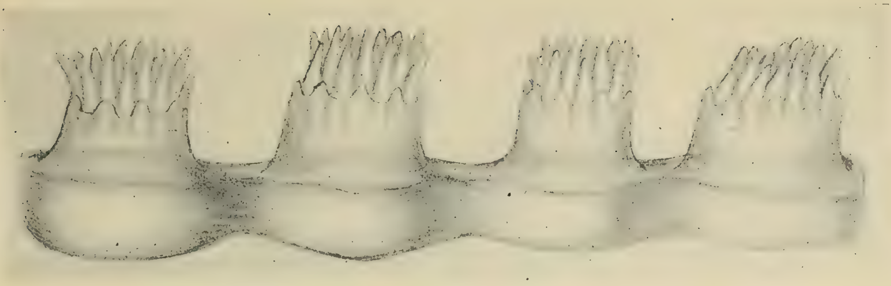


FIG. 1.

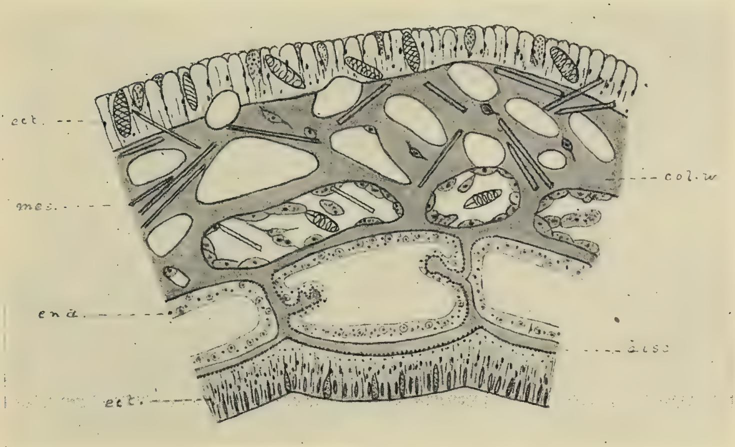


FIG. 2.

FIG. 3.

PARAZOANTHUS CATENULARIS.

Article XIX. — NOTES ON SOME SPECIES OF CATOCALA.

By William Beutenmüller.

In advance of a contemplated monograph of the genus *Catocala* the following notes on some species are presented, based mainly on material loaned to me by Mr. O. C. Poling and Dr. William Barnes, who have kindly placed at my disposal their extensive collections of *Catocala*.

Catocala aspasia *Strecker.*

On examination of the type of this species, I find it to be not a variety of *C. junctura* as it was placed in our list, but a distinct species, of which *C. augusta* Hy. Edw., *C. sara* French, and *C. sierræ* Beut. are varieties. A series of many examples before me vary considerably in the color of the fore wings, from gray to almost blackish, with a more or less clay yellow or pinkish tint. *C. augusta* has the transverse lines and shade heavily marked; *C. sara* more so; and *C. sierræ* is the almost blackish form. My determination of *C. aspasia* and *sara* were made from type specimens in the Strecker collection, and *C. augusta* from the type in the Edwards collection. I propose that the species and varieties be listed as follows:

Catocala aspasia Strecker.
" " var. *augusta* Hy. Edwards.
" " var. *sara* French.
" " var. *sierræ* Beutenmüller.

Catocala relicta *Walker.*

Walker's description of this well known species agrees with the variety *bianca* Hy. Edwards. Through the kindness of Sir George F. Hampson I obtained a colored figure of Walker's type in the British Museum, and it is identical with the variety *bianca*.

Catocala relicta var. **clara,** var. nov.

Fore wings almost uniform chalky white; basal area, spaces between the median shade lines and posterior geminate lines, creamy white. Transverse lines black, but not prominently. Reniform black with a white central ring, more or less broken. The black of the median shade contiguous on the costa with the reniform. Hind wings, abdomen, and thorax like the type form.

This is the common white form heretofore known as *C. relicta*.

The species and varieties now stand as follows:

Catocala relicta Walker (= *bianca* Hy. Edw.).
" " var. *phrynia* Hy. Edw.
" " var. *elda* Behrens.
" " var. *clara* Beuten.

Catocala herodias *Strecker.*

This certainly is a valid species and not a variety of *Catocala ultronia*, as placed by various authors. It is more closely related to *C. coccinata* than to *C. ultronia.* The wings are longer and are differently marked. A beautiful fresh example was taken by Mr. W. T. Davis at Lakehurst, New Jersey, which does not at all agree with *ultronia*, but with the type which I examined in the Strecker collection. I propose that the form be restored to specific standing. Strecker has already correctly pointed out this fact (Rhop. and Het., Supp. 3, 1900, p. 35).

Catocala arizonæ *Grote.*

After a careful examination of the type of this species in the collection of the American Entomological Society, I fail to find sufficient characters to separate *C. babayaga* from it. The only observable differences between the two are, *babayaga* is a trifle redder and has the markings on the fore wings less heavy than *arizonæ.* Dr. Barnes and Mr. O. C. Poling kindly placed in my hands a large series of *arizonæ*, which verify my conclusions. *Arizonæ* is subject to variation as regards the color and markings of the fore wings, which vary

in tone from grayish to reddish, with the markings more or less distinct.

Catocala aholibah var. **coloradensis,** var. nov.

Differs from the dark type form from California in having the fore wings light gray brown, covered with white scales, giving a light and somewhat faded appearance. The posterior transverse line is very distinct in this variety, and the hind wings are like the type form.

Habitat. — Glenwood Springs, Colorado. September 24–30.

Several specimens of this climatic variety are in the collection of Dr. William Barnes, Decatur, Illinois.

Catocala luciana *Hy. Edw.*

Dr. William Barnes and Mr. O. C. Poling kindly sent me for study a large series of this species. It varies considerably in color of the fore wings from light drab (type form), with heavy black, transverse lines, to almost uniform black, with the lines obscured by the dark ground color (var. *somnus*).

Catocala violenta *Hy. Edw.*

I consider this to be a valid species and not a variety of *Catocala verrilliana*, as it has been placed by certain authors. It is larger and longer winged, and the female is much more heavily marked than the male. The species described by Mr. Poling as *C. chiricahua* looks suspiciously like the female of *violenta*, and is probably the same. Mr. Doll has taken in Arizona a number of *violenta*, and the female agrees very well with *C. chiricahua* Poling.

Catocala jessica *Hy. Edw.*

The type of this species is in the collection of the American Museum of Natural History. It certainly is not a variety of *Catocala stretchii* as it was placed by the late Rev. George D. Hulst. In general appearance it looks somewhat like *C. arizonæ*, but it is much smaller. I would suggest that *C. jessica* be given specific rank until more material and evidence are at hand to show it to be merely a variety of *stretchii*.

Catocala amica var. **suffusa,** var. nov.

Fore wings gray like the type form but with the lower half almost entirely black from the base, thence obliquely to the apex. Upper half grayish white with the transverse lines and median shade black. In the black area the transverse lines and shade are scarcely or not at all evident. Hind wing like *C. amica.*

Habitat. — Florida, Texas, Iowa.

Described from two males and one female from the collection of Dr. William Barnes.

Catocala olivia *Hy. Edw.*

In shape and color of the wings like *Catocala alabamæ*, of which it is probably a variety. It differs from *alabamæ* only by the presence of a large subquadrate brown patch on the inner margin.

Catocala alabamæ *Grote.*

This certainly is not a variety of *Catocala grynea* as it is placed in our lists. The fore wings are less elongate and broader, and the transverse lines are different. It is apparently a valid species.

Catocala innubens var. **flavidalis** *Grote.*

Mr. Charles Dury tells me that this variety is based on a specimen in which the color has been changed by the action of heat or exposure to light. He has an example in which the color has been changed by heat in an oven, and which agrees with Grote's type in the British Museum.

Catocala barnesii *French.*

The type of this species was kindly loaned to me by Dr. Barnes. I consider it nothing more than a diminutive specimen of *Catocala agrippina*, hardly worthy of varietal rank.

Catocala amestris *Strecker.*

Larva. — Head bluish white with four black stripes on the front, not reaching the vertex; sides with irregular black spots; top with

more regular black spots. On each lobe on the top is a canary yellow patch. Sides at mouth parts also yellow. In shape it is narrower at mouth parts than on top; flattened in front, rounded at sides and on top. Body: Dorsal region yellowish; subdorsal region bluish white; sides bright yellow. On each side from dorsum to lateral parts are six black longitudinal lines, the two lower ones at the sides broader than the rest. In the yellow lateral region is a black line broken into spots. All the warts are bright yellow surrounded by a circle of the same color, giving the warts a large appearance. First segment edged in front and behind with bright yellow. Underside deep black. Abdominal legs black, yellowish inside. Thoracic feet black. Anal legs marked with yellow. Length, 50 mm.

Food-plant.—Locust (*Robinia pseudacacia*).

Described from living specimens found in the valley of the Black Mountains, North Carolina. The larvæ pupated July 19, and the imagos emerged July 9 and 10. Heretofore the larva was known only from an inflated specimen in the collection of the U. S. National Museum. The larva has no filaments at sides of the body or elevation on the eighth segment.

Catocala insolabilis.

Larva. — Head large, rounded, whitish, with lilac gray lines connected by fine reticulations. The lines become confluent in front near the top. On each side above the antennæ is a small black patch. Mouth parts lilac gray. Body smooth, lilac gray with numerous fine black irrorations, forming a band on each side of the dorsum and one on each side. Warts somewhat prominent, red. No elevation on the eighth segment. Eleventh segment with two short, blunt prominences directed backward. Sides with rather long grayish filaments. Underside a dirty white with a reddish tint. On each segment is a large black patch. Thoracic feet grayish. Length, 60 mm.

Described from a living specimen taken on hickory. The larva eats the soft part of the leaf on each side, leaving the ribs untouched. Found in the valley of the Black Mountains, North Carolina, June 4. Imago emerged July 10.

Catocala unijuga var. fletcherii, var. nov.

Fore wings with the markings as in *unijuga*, but much darker and heavier, especially the transverse anterior and posterior lines. Hind wings deep brown instead of red, with the median band and outer margin black. Fringes white, to the anal angle. Under side: Fore

wings brown black, white at base, and with a white oblique band before and one behind the middle; the former not reaching the inner margin. Apex gray. Hind wings similar to the upper side but the brown median black band is white above the middle to the costa. Thorax dark gray mixed with black. Expanse, 84 mm.

Habitat.— Regina, Assiniboia, Canada.

This remarkable form was collected by Mr. T. N. Willing, and kindly sent to me for study by Dr. James Fletcher.

Catocala hippolyta *Hy. Edw.*

This species was described from a single worn specimen, and the type is in the collection of the American Museum of Natural History. Mr. Poling sent me eight specimens which agree fairly well with the type. The fore wings are very pale ashen white, finely covered with darker scales. The transverse lines, reniform and subreniform, are more or less distinct, but not contrasting. The subterminal line is white. The hind wings are brick red with the median band variable in length and width, and it does not reach the inner margin. In some specimens this band is very much abbreviated and linear and has a tendency to disappear. The outer margin is broad, black, and the fringes are white. In general appearance *C. hippolyta* looks somewhat like *C. pura.*

Habitat.—Pasadena, California.

Catocala andromache *Hy. Edw.*

This species was described from a single broken specimen from California, and the type is in the collection of the American Museum of Natural History. A specimen labelled "type *C. andromache*" in the Neumoegen collection is not this species, but *C. ultronia.* Mr. O. C. Poling was fortunate enough to rediscover *andromache* in numbers in Southern Arizona in 1902. Two examples from Los Angeles, California, are also in the collection of the U. S. National Museum.

Article XX.—NOTES ON SOME BEETLES FROM THE BLACK MOUNTAINS, WITH DESCRIPTIONS OF NEW SPECIES.

By William Beutenmüller.

Plates XLVIII and XLIX.

Through the kindness and generosity of the late Very Rev. E. A. Hoffman, and Mr. Samuel V. Hoffman, the writer was enabled to make two expeditions to the Black Mountains, in western North Carolina, and adjacent ranges, in June and July, 1902, and May and June, 1903.

Three previous trips to the same general region were made in the interest of the Museum during August and September, 1895, July and August, 1900, and September and October, 1901.

In the course of these expeditions the following peaks have been explored by me in quest of insects: Mount Graybeard, Rocky Knob, and Toe River Gap in the Blue Ridge, which form the connecting link between the Blue Ridge and the Black Mountains; Cedar Pinnacle, Potato Knob, Clingman's Peak, Mount Gibbs, Steps Gap, Mount Hallback, Mount Mitchell, and Black Brothers, in the Black Mountains; and Bull's Head and Craggy Dome in the Craggy Range. The valleys as far as Balsam Gap in the Black Mountains, the Swannanoa Valley as far as Asheville, as well as other hollows and ravines, have been explored by me.

The forests of the Black Mountains are characterized by a dense growth of balsam fir (*Abies frazeri*) and black spruce (*Picea mariana*). In certain places they contain also mountain ash (*Pyrus americana*), wild red cherry (*Prunus pennsylvania*), hemlock (*Tsuga canadensis*), mountain maple (*Acer spicatum*), and rhododendron (*R. catawbiense*). The summits and slopes of the mountains are covered with a deep layer of damp moss, and the ground is strewn with fallen timber in various stages of decay. The Black Mountains derive their name from the dark foliage of the evergreens. The lowlands

are covered principally with red oak, white oak, sweet birch, locust, butternut, buckeye, tulip tree, hickory, laurel, rhododendron (*R. maximum*), and the fiery azalea (*A. lutea*).

The following are a few studies on some of the species taken in this interesting region, together with a description of a new *Platynus* from Retreat, Hayward County, N. C.

Nomaretus debilis, var. **alpinus,** var. nov.

Plate XLIX, Figs. 3, 5.

Five examples of this form were taken under stones and bark of trees in the valley and on the summit of the Black Mountains in June and September. The type form of *N. debilis* is a single male taken in Habersham County, Georgia. This form has the elytral striæ profoundly crenate or punctate, as shown on Plate XLIX, Fig. 4, which was drawn from the type in the Leconte collection. It measures 10 mm. in length and $3\frac{1}{3}$ mm. in width. The form taken by me in the Black Mountains is somewhat larger and more robust, and has the first, second, and third striæ only indistinctly crenate to a little beyond the middle. The remaining striæ are smooth and without punctures. Length of male, 10–11 mm.; width, $3\frac{1}{3}$–4 mm. Length of female, 12 mm.; width, 4 mm. I consider this form to be nothing more than a mountain race of *debilis*. Plate XLIX, Fig. 5, shows the anterior tarsus of the male.

Nomaretus imperfectus *Horn.*

Plate XLIX, Fig. 2.

A number of specimens of this species were taken in the valley of the Black Mountains. It occurs under decayed leaves in rhododendron thickets along the banks of slow running streams and is found very rarely under stones. It may be obtained by sifting.

Nomaretus hubbardii *Schw.*

Plate XLIX, Fig. 6.

Two females which I suppose to belong to *N. hubbardii* were taken in the Black Mountains, one in the valley and the other

on the summit of Mount Mitchell, altitude 6717 feet. It is possible that these may prove to be a new form.

Cychrus viduus, var. **irregularis,** var. nov.

PLATE XLVIII, FIGS. 5, 6, 7.

Shape of *C. viduus.* Deep purplish black or almost black above. Deep black beneath. Elytra with the intervals more or less broken alternately, and forming irregular, elevated reticulations; punctures large and deep. Length of male, 25–29 mm.; female, 28–30 mm.

Habitat. — Summit of Black Mountains, North Carolina, Roan Mountains, Tenn., and Clingman's Dome, Smoky Mountains, Tenn.

Described from four males and three females from the Black Mountains. Types, Coll. Am. Mus. Nat. Hist. In *C. viduus* (Plate XLVII, Figs. 8 and 9) the color is purple, the striæ are regular and less coarsely punctured, and the intervals are complete and regular in their course. The anterior tarsi of the male are like *viduus* (Plate XLVIII, Fig. 7). Specimens of this form from the mountains in Tennessee are also in the collection of Mr. Wenzel.

Cychrus guyoti *Lec.*

PLATE XLVIII, FIGS. 1, 2, 3, 4.

Five males and three females of this rare species were taken on the summits of the Black Mountains, during May, June, and July. The type in the Leconte collection is an immature female from the same region. Plate XLVIII, Figs. 3 and 4, were drawn from the type. The first joint of the anterior tarsi of the male (Plate, XLVIII, Fig. 2) is very long, narrow, and scarcely dilated at the tip, as in the other eastern species of the genus. The 9th, 10th, and 11th intervals of the elytra from before the middle to the tip are more or less irregularly broken.

Cychrus violaceus *Lec.*

PLATE XLVIII, FIGS. 10, 11.

This species should be looked for in the mountains of North Carolina, but my search so far to discover it has not

been successful. The type in Leconte's collection is a single male from the mountains in Georgia. A specimen from the mountains in North Carolina (Plate XLVIII, Fig. 12) before me agrees in all respects with the type of *violaceus* except that the thorax in my specimens is broader. The anterior tarsi, color, and sculpture are the same. In color *violaceus* is like *C. andrewsii* from North Carolina, but the first joint of the anterior tarsi (Plate XLVIII, Fig. 11) is longer and less clothed with pubescence. *Violaceus* was placed by the late Dr. Horn as a variety of *C. viduus* (Trans. Am. Ent. Soc., Vol. VIII, p. 173). It certainly is not a variety of this species, but more likely of *C. andrewsii*. I would propose to give *C. violaceus* specific standing until more evidence and material are at hand to unite it with *C. viduus* or *C. andrewsii*. Figures 10 and 11 on Plate XLVIII are from Leconte's type in the Cambridge Museum.

Cychrus andrewsii *Harris.*

PLATE XLVIII, FIG. 7, AND PLATE XLIX, FIG. 1.

Cychrus andrewsii HARRIS, Boston Journ. Nat. Hist., Vol. II, 1839, p. 195.

The original description of this species is as follows:

"*Black; thorax deep greenish blue, heart-shaped, narrowed behind, and slightly margined at the sides; elytra deep blue, faintly tinged with violet, slightly carinated at the base and sides, and with punctured striæ.*

"Length, including the mandibles, nine and a half lines.

"*Head*, blue black, smooth, obsoletely wrinkled on the front, and impunctured. *Thorax*, heart-shaped, very much narrowed behind, rounded at the sides, with a small elevated lateral ridge, furrowed in the middle, and slightly depressed before the base, which is covered with shallow, irregular punctures. *Elytra* oblong-ovate, quite convex, and very slightly carinated at the shoulders and sides; they are marked with fine and narrow punctured striæ; but the striæ become obsolete and the punctures irregular and more dilated, at tip. *Epipleuræ* greenish black and punctured. *Body* beneath black. *Legs* black; tarsi rust-colored.

"Inhabits North Carolina."

Twenty examples agreeing with the original description were collected by me in the valley of the Black Mountains,

principally on the slopes at the base of the mountains. My specimens vary in color from bright violet to bluish. The males measure from 17–20 mm. in length, and the females from 18–22 mm. Plate XLVIII, Fig. 14, shows the anterior tarsus of the male.

Cychrus æneicollis, sp. nov.

PLATE XLVIII, FIG. 13.

Head black, very slightly greenish or purplish, finely wrinkled, especially between the eyes. Thorax greenish or purplish black, narrowed behind, lateral edge narrowly reflexed; sides rather strongly but obtusely angulated, giving a very characteristic appearance; median sulcus deep; transverse impression in front rather deep; basal impressions deep, punctulate. Elytra convex, dark greenish or purplish black, with the punctures on the striæ large, deep, and pitlike. Intervals more or less irregular, especially at the sides, where they form in some specimens a regular network. The intervals are also more or less transversely connected. Under side and legs black. Length: male, 14–19 mm.; female, 19–22 mm.

Seventy fine specimens of this mountain form of *Cychrus* are before me. They were all taken on the summit of the Black Mountains from May to October. They live in the deep, dense forests, and usually are found under loose bark. Specimens of the same form are in Mr. Wenzel's collection from the Balsam Mountains, N. C., and mountains in Tennessee. It is probably an alpine form of *andrewsii*, but differs from this species in color, form of thorax, and sculpture of the elytra. The thorax in the mountain form is strongly angulated at the sides, the striæ of the elytra have large, deep pitlike punctures, and the intervals are more irregular. In *andrewsii*, at least the North Carolina specimens, the striæ are finely punctured, with regular and continuous intervals, except at apex. *Andrewsii* is bright violet or violet blue, while in the form here described they are deep green or purple black. The thorax is also relatively narrower and the head longer than in *C. andrewsii*. The anterior tarsi are the same as in *C. andrewsii*. Whether or not it is a form of *C. andrewsii* I am not prepared to say. All my specimens were taken on the summit of the mountains, very rarely on the slopes, near the

base; while all the *C. andrewsii* were taken in the valley and not on the summit. It is found from May to late in the fall, and probably hibernates.

Cychrus stenostomus, var. **bicarinatus** *Lec.*

In the valley of the Black Mountains and southward to Georgia this form is not uncommon. Specimens were collected by me from May to October. The type in the Leconte collection is a unique male from Habersham County, Georgia. *Cychrus stenostomus*, or var. *lecontei* is not found, as far as I am aware, in the mountains of North Carolina. *Bicarinatus*, on the average, is larger, more robust, and with the intervals of the elytra more or less carinated. The intervals are also more or less broken, forming distinct tubercles behind the middle to the apex.

Cychrus canadensis *Chd.*

Thirty specimens of this species were taken on the summits of the Black Mountains, from May to October. It is found under bark or moss on rocks. The species does not seem to occur in the valley.

Trechus carolinæ *Sch.*

This species was described from a single specimen taken by me on the summit of Potato Knob, in the Black Mountains. It was taken in July, by sifting the damp moss covering these mountains. On my last trip (1903), I was fortunate enough to find two additional specimens of this rare species. They were found on May 19, near the foot of Mount Mitchell, under a large stone deeply imbedded in the ground. They were probably hibernating.

Platynus trifoveolatus, sp. nov.

Plate XLIX, Fig. 7.

Head, thorax, and elytra pitchy brown; margins of the thorax, elytra, antennæ, and legs rufo-testaceous; under side of body darker. Head rather large, smooth, frontal impressions deep. Thorax longer

than broad, narrower behind than in front, sides evenly rounded before the middle, thence almost evenly oblique to the hind angles, which are rectangular; basal impressions deep and finely rugose; sides strongly reflexed, especially at the hind angles; anterior angles obtusely rounded; median impression deep. Elytra oval, convex, about a third longer than broad, sides rounded, lateral margins rather strongly reflexed, humeral angles well rounded; sinuate before the tip; striæ deep, intervals convex; lateral striæ faint. On the third interval with three foveæ.

Length, 4.75 mm.; width, 2.75 mm.

Habitat. — Pigeon River, Retreat, western North Carolina.

Types. Coll. U. S. Nat. Mus.; 2 cotypes, Am. Mus. Nat. Hist.; 2 cotypes, Am. Ent. Soc. (Horn Coll.).

Described from six specimens collected by the late H. G. Hubbard. The specimens were kindly loaned to me for study by Mr. E. A. Schwarz.

A small, oval species, resembling *Platynus ruficornis* and *P. crenistriatus* in general appearance, but the strongly reflexed margins of the thorax and other characters place it in the *sinuatus* group.

Platynus gracilentus, sp. nov.

Plate XLIX, Fig. 8.

Head as broad or almost as broad across the eyes as the broadest part of the thorax, smooth, shining. Thorax rather narrow and long, narrower behind than in front; sides reflexed, rounded in front, thence oblique to before the hind angles, where it is slightly sinuate; hind angles rounded. Median sulcus distinct, rather deep anteriorly. Basal impressions deep. Elytra very much narrower at the base than before the apex; sinuated before the tip. Striæ deep; intervals convex or more or less flattened. Color black; femora black, tibiæ and tarsi brown.

Length, 11–14 mm.

Habitat. — Summit of the Black Mountains, N. C.; altitude, 5000–6717 feet.

Types. Coll. Am. Mus. Nat. Hist.

Allied to *P. angustatus*, but differs from this species by having the thorax elongate and considerably narrower; the elytra are less ovate and narrower, especially at the base. It is also smaller, and more graceful and slender. About one hundred and fifty specimens were collected, under bark and

stones. The species does not occur in the valley, while *P. angustatus* occurs both in the valley and on the summit of the mountains. I was at first inclined to believe that this species was a form of *P. angustatus*, but in no instance could I find the two species co-habiting. They were all found apart from *P. angustatus*.

Corymbites longicornis *Lec.*

As far as I am aware only two specimens of this species are known to exist in collections,—one in the Leconte, and the other in the Horn collection. On the summit of Mount Graybeard, in the Blue Ridge, N. C., in May, I captured on low bushes about forty specimens of this rare species. It may be known readily by its long antennæ and slender form. In color it is very pale testaceous, with a broad black sutural line.

Anthophilax hoffmanii, sp. nov.

PLATE XLIX, FIGS. 9, 10.

Male: Head and thorax brassy black or purplish. Antennæ black. Elytra bright shining green, red laterally; scutellum black. Underside black or brassy black with very short whitish hairs. Legs brassy black, pubescent; tibiæ somewhat rufous basally. Head rugose, with a median sulcus in front, carinate on each side from below the antennæ to the mandibles. Thorax deeply rugose, narrower in front than behind; a median depression on the anterior half and a transverse, smooth ridge near the base. Anterior portion somewhat constricted; hind angles rather prominent, produced by the lateral depression. On each side at the middle is a prominent spine-like protuberance. Antennæ fully as long as the body. Elytra rugosely reticulated; humeri prominent. Underside very finely rugose. Length, 13–15 mm.

Female: Color same as in the male, but considerably larger and more robust. The hind angles of the thorax are considerably more produced and the lateral protuberances are longer and more pointed. The red on the sides is also narrower, and the antennæ reach to one third from the tip of the elytra. Length, 18–20 mm.

Habitat. — Summits of the Black Mountains, western North Carolina, June 26–July 11, 1902.

Types. Coll. Am. Mus. Nat. Hist. One female cotype, Coll. Am. Ent. Soc.

Described from two males and four females. Dr. Van Dyke, who was with me on this trip, captured also one male and three females of this beautiful longicorn.

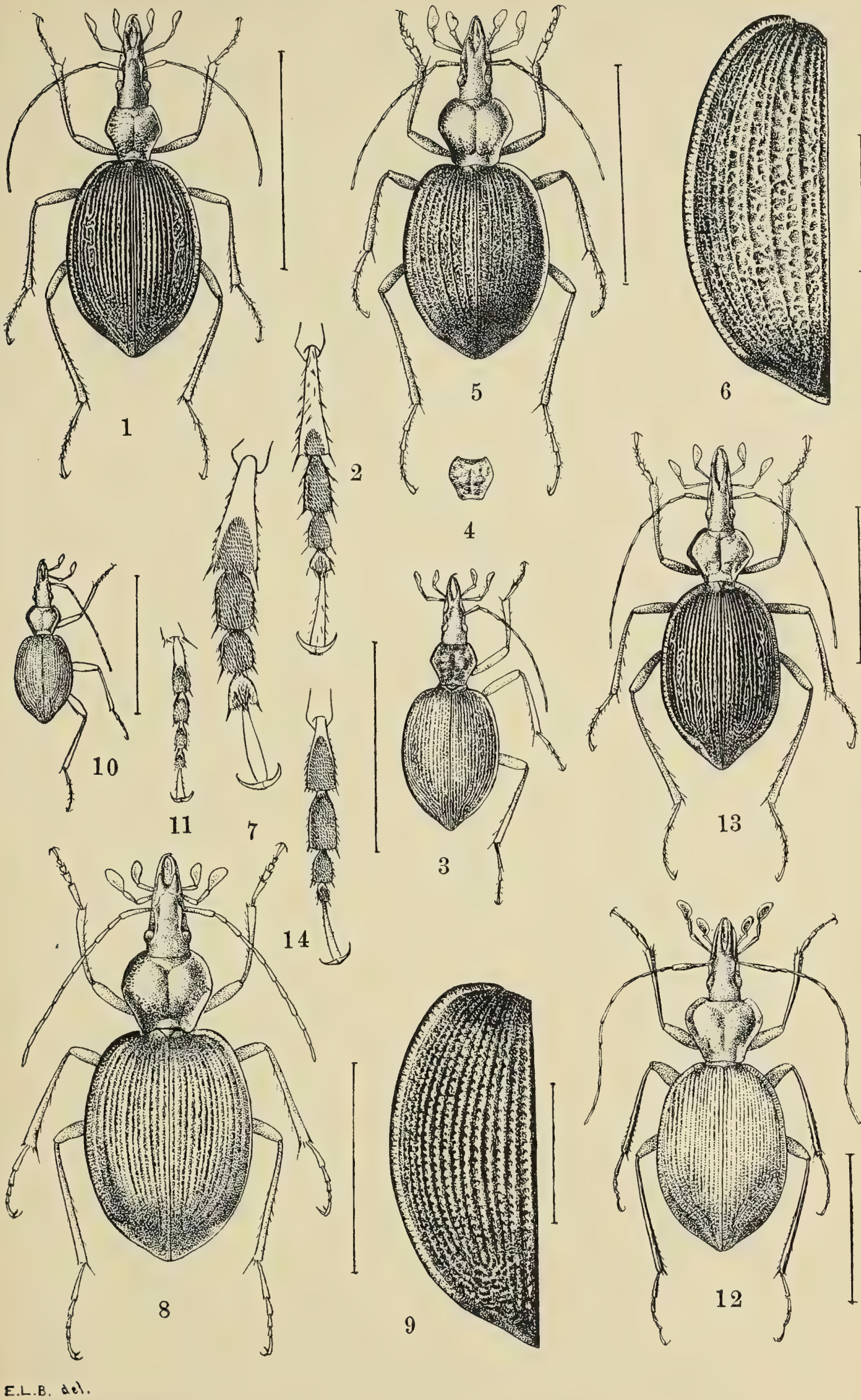
The species was found only on the balsam fir (*Abies frazeri*), on which a female was found ovipositing.

It is allied to *Anthophilax viridis* (Plate XLIX, Fig. 11) and *malachiticus*, but differs from these species by having the thorax considerably broader behind, the sides more oblique, and the lateral protuberance considerably more prominent, especially in the female. It is also a larger and more robust insect. I take pleasure in naming this species in honor of the late Very Rev. E. A. Hoffman.

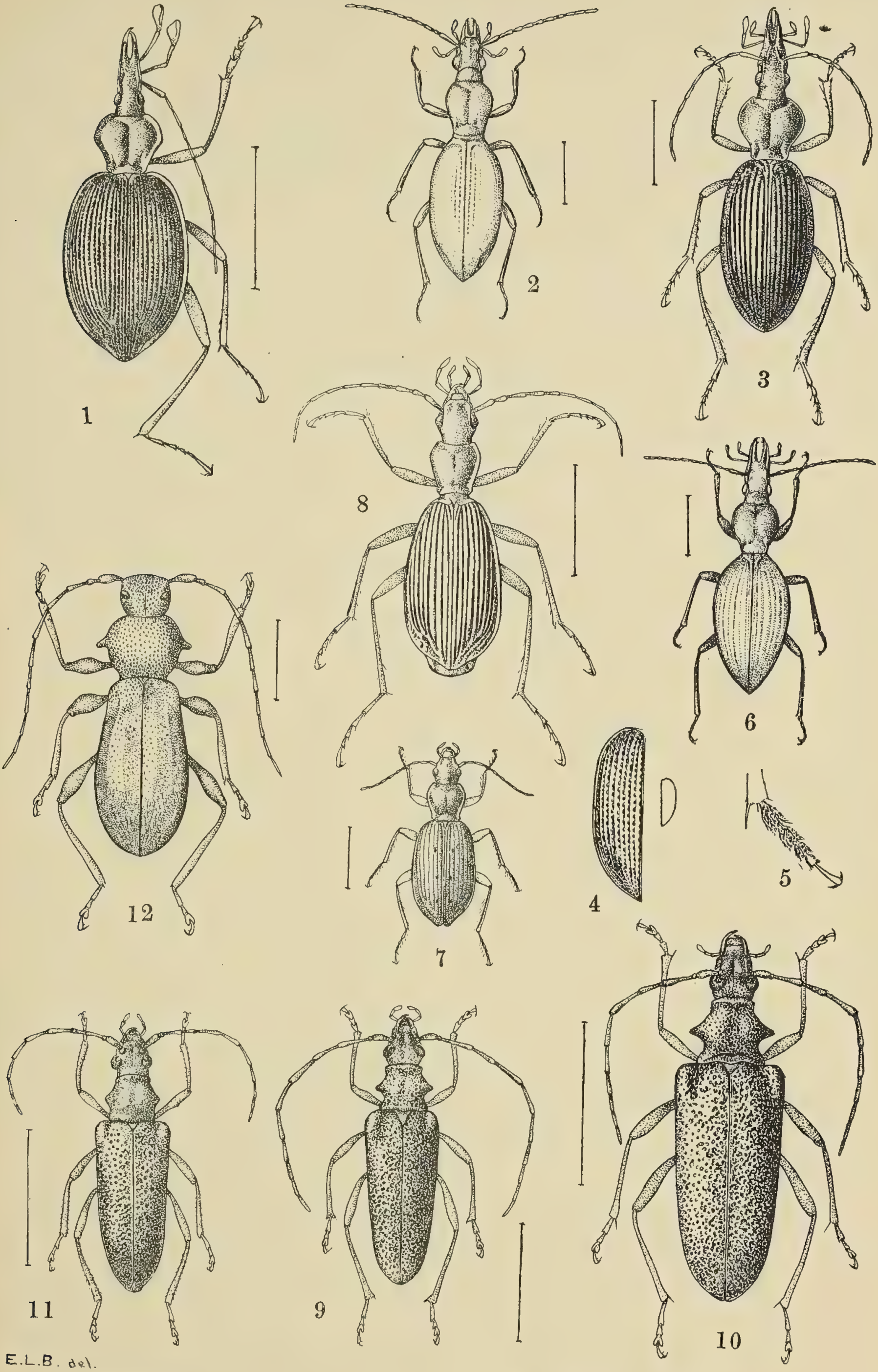
Michthysoma heterodoxum *Lec.*

Plate XLIX, Fig. 12.

Twelve specimens of this curious ant-like longicorn were collected in the valley of the Black Mountains and on the summit of Mount Graybeard of the Blue Ridge. It was found running on the trunks of oak and chestnut trees. In shape and habits it resembles black ants.



1. Cychrus guyoti. Female.
2. " " anterior tarsus. Male.
3. " " Female.
4. " " thorax.
5. " viduus var. irregularis, var. nov.
6. " irregularis, elytra.
7. " var. irregularis, anterior tarsus. Male.
8. Cychrus viduus.
9. " " elytra.
10. " violaceus.
11. " " anterior tarsus. Male.
12. " " var.
13. " æneicollis, sp. nov. Male.
14. " " anterior tarsus. Male.



1. Cychrus andrewsii.
2. Nomaretus imperfectus.
3. " debilis, var. alpinus, var. nov.
4. " " elytra.
5. " " anterior tarsus, male.
6. " hubbardii.
7. Platynus trifoveolatus, sp. nov.
8. " gracilentus, sp nov.
9. Anthophilax hoffmanii, sp. nov. Male.
10. " " Female.
11. " viridis.
12. Michthysoma heterodoxum.

Article XXI. — MAMMALS COLLECTED IN ALASKA AND NORTHERN BRITISH COLUMBIA BY THE ANDREW J. STONE EXPEDITION OF 1902.

By J. A. Allen.

The collection of mammals obtained by the Andrew J. Stone Expedition [1] of 1902 numbers nearly 1100 specimens, representing 43 species and subspecies, some of them by very large series; it includes about 50 head of large game, and a series of 31 skulls of the Kadiak Bear. In completeness, for the area principally worked, and in the quality of the material obtained, the results merit the highest praise. The field of operation was mainly in the Cassiar District of northern British Columbia, as shown by the following brief statement of the itinerary.

Mr. Stone left New York April 5, to outfit at Seattle, Washington. He left Seattle April 25, via Juneau, for Sand Point, Alaska, where he arrived May 12. From Sand Point an expedition was made to the Stevana flats, seventy-five miles inland, for the purpose of procuring specimens of the big brown bear (*Ursus merriami* of the Stone Expedition report for 1901[2]) discovered by him in 1901, and incidentally to obtain accessories for a group of the Grant Caribou, also discovered by him in 1901.[3] While successful in this last particular, the month's hunt for bears proved futile, only three bears being seen and none obtained. The reason for this failure is thus stated in Mr. Stone's report on the season's work: "All the large bears of western Alaska are rapidly becoming exterminated. Most of the country inhabited by them is easy of access, and in many places the cover is very slight for such large animals. There is every evidence that they were once very plentiful on Stevana flats and in the mountains surrounding the flats. Well-worn, but old trails are numerous, and reports of large numbers being killed there

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[1] For an account of the origin, maintenance, and proposed work of the Andrew J. Stone Expedition see this Bulletin, Vol. XVI, 1902, p. 125.
[2] See this Bulletin, Vol. XVI, 1902, pp. 141, 227.
[3] *L. c.*, pp. 119–127.

some years previous are still current. A single hunter is reported to have killed forty-five animals in one season's hunt. But, as in many other places in the best game countries, it is this sort of thing that is making animal life scarce."

On his return from the North he reached Juneau on June 26, and arrived at Wrangel the following day. Here he found Mr. M. P. Anderson, his assistant, already at work collecting small mammals. The party left on July 8 for the headwaters of the Stickine River, in which general region collecting was carried on till October 23. The party then returned to the coast, and two weeks were spent on Kupreanof Island, collecting deer and small mammals.

Work in the interior was begun at Telegraph (village), July 10, and continued there until August 18, with a side trip into the Cheonnee Mountains, to the south of Telegraph Creek, and others to the 'Summit,' twelve miles north of Telegraph. The country about Telegraph is described by Mr. Anderson, in his MS. report, as broken, the river, below the village, flowing between terraced hills, which gradually rise toward the mountains. "The terraces, sometimes three in number, are composed of drift, and are broken and irregular. Above the village the walls of the river become more precipitous, and there are frequent basaltic cliffs, with taluses sloping to the water's edge. Back of the village, on each side of the creek, rise cliffs with talus piles, and above these other terraces, level bottoms, and flat-topped hills. Wherever rock appears in place it is lava." The timber consists of 'black pine,' a spruce, two species of juniper, growing in low patches on the dry hillsides, poplars and a few birches. Raspberries were abundant everywhere, sabis berries on the hillsides, and gooseberries, strawberries and currants were more or less plentiful in suitable places.

No attempt was made here to collect large mammals, but about 650 small mammals were obtained during the stay at Telegraph Creek, including those taken on the side trips to the Cheonnee Mountains and the 'Summit,' at the head of Telegraph Creek.

Mr. Stone, with his three assistants, and four animals carry-

ing the camp outfit and supplies, left Telegraph Creek August 16, reaching Shesley, a Government telegraph station, on the headwaters of Shesley River, forty-five miles distant, on the 19th. A part of the supplies were left here and a trip made into the Shesley Mountains, for large game. Four Mountain Goats were killed *en route*, but fell into inaccessible places and were lost. "On the afternoon of August 22," continues Mr. Stone in his MS. report, "camp was pitched among some low balsams, just at the upper edge of timber-line, after having travelled a swampy mountain plain all day. Confronting us in every direction were very rugged mountains, cut by deep cañons. To secure goats and sheep was the special object of this hunt, but after the first three sheep were taken I decided that the coat was yet too short for mountable specimens, and did not try for any more. Four splendid specimens of goats were secured, one Black Bear and a Grizzly mother and her cub." Also about 140 small mammals were taken on the Shesley trip.

The camp at the head of Shesley River is described by Mr. Anderson as "situated at timber-line on the side of a mountain, which, rising above us, formed a plateau barren of vegetation, except for a few lichens and here and there a little bunch grass. The side where we were camped, however, had considerable grass where there were depressions that gathered moisture or where little streams ran. Below us on the side away from the plateau ran a considerable glacier stream in a deep cañon. Between the plateau and the high snow-covered mountains from which this stream ran, there was a broad valley through which flowed another glacier stream to join the first. The valley was broken into innumerable hills and knolls, among which were small lakes. The timber here consisted of scrubby balsam fir, with here and there a pine. Willows and other shrubs were abundant in the broad valley, but the ground was largely covered with mosses and lichens, and bunch grass grew in the dry places."

The party later returned to Shesley, and on September 6 started for Level Mountain, some fifty miles further on, and about one hundred miles southeast of Telegraph Creek. At

Level Mountain 5 Moose, including an adult female with twin calves, 9 Caribou, and 1 Red Fox, and about 100 small mammals were secured. On the return trip Telegraph Creek was reached September 27. From this point a trip was made to Iskoot Summit, distant about forty-five miles, for the purpose of making a collection of the Stone Sheep, first discovered by Mr. Stone in the Cheonnee Mountains, in August, 1896. Six sheep were secured, consisting of two old females, a three-year-old ram and several lambs. A second trip was made to the Cheonnee Mountains during the third week of October, in the hope of securing some large rams, but the weather turning cold, with heavy snow-falls, the trip proved dangerous and unsuccessful.

The final departure from Telegraph Creek for Wrangel was made on the 23d of October, and later, as already stated, nearly two weeks were devoted to collecting on Kupreanof Island.

From the foregoing it will be seen that quite diverse localities were covered, as regards elevation and other conditions, so that a thoroughly representative collection was made in the region of the headwaters of the Stickine River, and from Wrangel and Kupreanof Islands. The species obtained are, arranged by localities, as follows:

Alaska Peninsula.

Phoca richardii pribilofensis.
Ursus middendorffi.
Gulo luscus.

Wrangel and Kupreanof Islands.

Odocoileus columbianus sitkensis.
Sciurus hudsonicus vancouverensis.
Citellus stonei, sp. nov.
Peromyscus sitkensis.
Evotomys wrangeli.
Microtus macrurus.
Ursus sitkensis.
Sorex personatus streatori.
" longicauda.

Telegraph Creek Region.

Rangifer osborni.
Paralces gigas.
Ovis stonei.
Oreamnos montanus.
Sciurus hudsonicus baileyi.
Eutamias caniceps.
Citellus erythrogluteius.
Marmotta caligata.
Mus musculus.
Peromyscus arcticus.
" oreas.
Neotoma cinerea saxamans.
Evotomys dawsoni.
Microtus mordax vellerosus.
" drummondi.

Telegraph Creek Region.
(*Continued.*)

Fiber spatulatus.
Phenacomys constablei.
Synaptomys andersoni, sp. nov.
Lemmus helvolus.
Zapus saltator.
Erethizon epizanthus nigrescens, subsp. nov.
Lepus saliens.
Canis occidentalis.
Vulpes alascensis abietorum.
Ursus horribilis.
" americanus.
Putorius cicognanii richardsoni.
" microtis, sp. nov.
Sorex personatus.
" obscurus.
" palustris alaskanus.

It will be seen from the above that none of the species or subspecies is common to both the Sitkan coast and the Telegraph Creek region.

In regard to the personnel of the Expedition, Mr. Stone had with him as field assistants Mr. Malcom P. Anderson, a student of Stanford University, who was engaged especially to take charge of the work of collecting small mammals; Mr. Belmore H. Browne, of Tacoma, Washington, as general field assistant; and Dennis, a Tahltan Indian, who did good service as a hunter and trapper. Mr. Stone speaks in the highest terms of their efficiency and faithfulness. While Mr. Stone is personally to be credited with the capture and preservation of the large game, he also assisted whenever possible in the small mammal collecting, with a view to securing as large and as varied a collection as possible. All the specimens were carefully measured in the flesh before skinning, and the measurements, especially in the case of the large series of small mammals, bear internal evidence of the care with which they were taken and recorded.

A type-written report of the season's work was submitted by both Mr. Stone and Mr. Anderson, the latter's relating especially to the small mammals and the character of the localities at which they were collected. These reports have been extensively drawn upon in the foregoing introduction, and many of Mr. Anderson's field notes will be found quoted in the following annotated list of the species.

The only special faunal paper bearing upon the mammals of the Telegraph Creek region is a short report on the collection made by Mr. Stone in 1897–98 (this Bulletin, Vol. XII, 1899,

pp. 1–9); but Mr. Wilfred H. Osgood's 'Results of a Biological Reconnoissance of the Yukon River Region' (N. Am. Fauna, No. 19, October, 1900, pp. 1–45) is of special interest in this connection, since he made collections in the Lynn Canal and White Pass districts, not far to the northwestward of Telegraph Creek, and from which he described a number of new species and subspecies represented in the present collections.

In this connection I wish to express my great indebtedness to Dr. A. K. Fisher, Acting Chief of the Biological Survey, U. S. Department of Agriculture, for the loan of topotypes of Mr. Osgood's species and other needed material for use in the preparation of the present paper.

1. **Rangifer osborni** *Allen.* OSBORN CARIBOU.

Rangifer osborni ALLEN, Bull. Am. Mus. Nat. Hist., XVI, 1902, 140. April 16, 1902. Cassiar Mountains, B. C.

Represented by a series of 9 fine specimens, skins and skulls, carefully prepared for mounting, consisting of 6 males and 3 females, taken on Level Mountain, September 14. The females and four of the males are fully adult, and measure in the flesh as follows: 4 males, total length, 2112 (2048–2211); tail, 191 (178–203); hind foot, 619 (597–635); height at shoulders, 1400 (1334–1499). The 3 females: Total length, 1545 (1473–1651); tail, 174 (165–178); hind foot, 571 (559–600); height at shoulders, 1051 (967–1119).

The general color above is blackish brown, or dark clove brown, the dark color of the back extending to the base of the tail; chest, flanks, and front of legs black; belly white; neck dingy brownish gray, with a white median band in front from the throat to the chest, well developed in some of the specimens and rather indistinct in others; head and face blackish brown, like the back. The antlers in the older males are strikingly large and fine, nearly equalling in size those of the Wapiti Deer.

2. Paralces gigas (*Miller*). Alaska Moose.

Alces gigas Miller, Proc. Biol. Soc. Wash., XIII, May 29, 1899, 57. Tustumena Lake, Kenai Peninsula, Alaska.

Six specimens, collected as follows: An adult female, Shesley Mountains, August 24; an adult female and her twin calves, and two young adult males, Level Mountain, September 10–18, all carefully prepared for mounting.

These specimens are very dark colored, being nearly black and hence much darker than the eastern Moose from northern Maine and New Brunswick. The two young adult males have small antlers, but mature dentition, although the teeth are still unworn. The measurements of these specimens, taken in the flesh before skinning, are as follows:

Mus. No.	Sex.	Total length.	Tail vertebræ.	Hind foot.	Height at shoulder.
19802	♂	2540	178	825	1839
19803	♂	2540	178	825	1814
19798	♀	2540	203	775	1778
19799 [1]	♀	2375	191	787	1814
19801	♂ juv.	1698	102	641	1320
19800	♀ "	1651	102	635	1308

The skulls of the two females (adult but not old, the teeth being but very little worn) measure as follows: Total length, 587, 578; basal length, 560, 543; naso-occipital length, 353, 348; front border of premaxillæ to front end of nasals, 260, 250; length of nasals, 108, 102; zygomatic breadth, 191, 200; mastoid breadth, 141, 152; breadth at fronto-parietal suture (= postorbital construction), 92, 89; length of upper toothrow, 147, 142; length of lower jaw, 450, 457; height at condyle, 157, 146; height at coronoid, 215, 217; lower toothrow, 155, 150. The skull of a young male, with complete but unworn dentition, is intermediate in measurements between the two females, while another young male skull of practically the same age is slightly larger than the larger of the two females.

[1] Mother of Nos. 19800 and 19801, twins, about six months old.

These specimens are much larger than specimens of the eastern animal of corresponding age, and in their dark coloration resemble Kenai Peninsula specimens, to which they are provisionally referred.

3. **Odocoileus columbianus sitkensis** *Merriam.* Sitka Deer.

Odocoileus columbianus sitkensis Merriam, Proc. Biol. Soc. Wash., XII, 1898, 100, April 30, 1898. Sitka, Alaska.

Fourteen specimens, all in fine condition for mounting, collected on Kupreanof Island, southeastern Alaska, November 3–14. The series contains adults of both sexes, several young males, and a young-of-the-year female.

The type, from Sitka, Alaska, was an immature female, killed August 6, and had "patches of gray winter coat." As the present specimens, all killed during the first half of November, are in practically full winter coat, the following description, based on this material, is appended.

Adult Male (November). — General color, pale yellowish brown with a slight grayish cast, darker along the median line of the back and lighter on the flanks; the hairs individually are basally light ash gray, broadly ringed near the tip with blackish and strongly tipped with deep buff; nose with a broad terminal band of black, laterally not quite reaching the lips; face whitish gray as far back laterally as the eyes, which are nearly enclosed in this light area, behind which is a broad V-shaped band of black, beginning anteriorly considerably in front of the plane of the eyes, and extending backward about midway between the posterior border of the eyes and the base of the horns, and blending on top of the head with a blackish area varied with rusty brown (deepening in some specimens to chestnut); cheeks pale buffy gray; neck all round and chest like back; chin white, followed by a band of pale yellowish brown; a patch of black on either side of the lower jaw about midway between the tip of the chin and the angle of the mouth, varying in extent and sharpness in different specimens; throat and upper part of neck in front white, followed by a broad band of brown, and this again by an indistinct half-collar of grayish white; pectoral region darker than the back, in some specimens quite blackish; axillary region and inside of fore legs white, the white on the legs becoming buffy white distally; outside of upper part of fore legs like the flanks, the legs becoming paler and yellower distally, passing into ochraceous on the feet; middle of belly, inguinal region

and inside of hind legs white, the white on the legs decreasing in width distally and terminating a little below the tarsal joint; outside of hind legs proximally like the body, becoming ochraceous brown below the tarsal joint and deepening in color distally to deep ochraceous on the feet; tarsal gland dark rusty brown or dull chestnut, usually with a blackish tinge; ears externally gray, passing into pale buff basally, and white internally, with a slight fringe of buff; tail above at base like the rump, passing gradually into black, which occupies from about one-half to two-thirds its length; lower side of tail white, the white also forming a terminal fringe visible from above. Antlers dark reddish brown; they are small, but very symmetrical and handsome in the old males.

The foregoing is based on a middle-aged male in prime condition, but the coloration in the series of fourteen specimens, including females and young males, is so uniform that the variations are hardly worth noting, and are fairly covered by the qualifications above expressed. They relate mainly to the distinctness of the black face and chin marks, the extent of the black area on the tail, the intensity of the fulvous tints on the legs, and the dusky shading on the pectoral area, which is sometimes quite blackish. In the adult males there is also very little variation in size, either in external measurements or in the skulls, as shown by the following:

External measurements of 3 adult males: Total length, 1508 (1500–1524); tail vertebræ, 127 (127–127); hind foot, 436 (432–438); height at shoulders, 902 (889–908). A fourth adult male measures slightly smaller. The two adult females are much smaller, except that the tail is much longer, as follows, respectively: Total length, 1321, 1283; tail vertebræ, 165, 165; hind foot, 406, 406; height at shoulders, 835, 762. The ear from the notch, as well as can be determined from the skins, varies from about 115 to 125.

Skull measurements of 3 adult males: Total length, 266 (265, 266, 266); basal length, 254 (253, 254, 255); naso-occipital length, 215 (211, 216, 218); front border of premaxillæ to front end of nasals, 64 (65, 65, 63); length of nasals, 77.3 (73, 76, 83); zygomatic breadth, 112 (112, 112, 112); breadth of braincase at fronto-parietal suture (= post-orbital constriction), 73 (74, 73, 72); mastoid breadth, 97 (95,

100, 95); length of upper toothrow, 69 (68, 69, 69); length of lower jaw, 202 (198, 201, 208); height at condyles, 75 (75, 75, 75); height at coronoid process, 109 (110, 110, 107); length of lower toothrow, 72 (72, 72, 72); antlers: length of main beam, following external curvature, 336 (285, 352, 370); distance between points of main beam, 303 (260, 320, 330); across point of greatest convexity of main beams, outside to outside, 393 (387, 385, 408). The specimen with the smallest antlers is the oldest of the three, or at least has the teeth most worn.

4. **Ovis stonei** *Allen.* Stone Sheep.

Ovis stonei Allen, Bull. Am. Mus. Nat. Hist., IX, 1897, 111. April 8, 1897. Head of Stickine River, B. C.

Ovis canadensis liardensis Lydekker, Wild Oxen, Sheep, and Goats, 1898, 215, fig. 41. Liard River, lat. 59° N.

Nine specimens, collected as follows: Shesley Mountains, 3, August 24; Iskoot Summit, 6, October 4–10. They are mostly young adults, but include one quite young lamb, three old females, and a three-year-old male. The flesh measurements of the three adult females are: Total length, 1359 (1321–1410); tail vertebræ, 110 (102–114); hind foot, 385 (381–393); height at shoulders, 879 (864–896). The three-year-old male: Total length, 1283; tail vertebræ, 127; hind foot, 406; height at shoulders, 902. A female lamb in the soft first pelage: Total length, 759; tail vertebræ, 76; hind foot, 279; height at shoulders, 559. The largest of these three females is very old, with worn-out teeth; the others are fully adult.

The August specimens are in much shorter coat and lighter in coloration than those killed in October. The lightest colored specimens are dingy gray-brown finely varied with black hairs. The three-year-old ram is almost black—the darkest specimen I have yet seen — the general color being sooty or brownish black, — nearly black across the shoulders, sides of the shoulders, flanks, and front of the legs. A narrow black stripe runs from the dark area of the back to the tail, dividing the white rump patch into two halves. This feature

is seen in four other specimens, but in the four remaining specimens the black stripe is broken by the rump patch.

The young lamb in first pelage has the coat very fine and soft, of a dull drab gray, with a pale rusty tinge over the shoulders; legs darker; tail stripe continued on to the back.

5. **Oreamnos montanus** (*Ord*). MOUNTAIN GOAT.

Four specimens, Shesley Mountains, August 24–28. All are males, three of them being old adults and the other about half grown. They are in poor coat, and the color is soiled white, quite different from the clear white of winter pelage. Following are the measurements of the three adult males: Total length, 1625 (1549–1676); tail vertebræ, 191 (178–203); hind foot, 356 (343–368); height at shoulders, 971 (929–992). The smallest specimen of the three (represented by the minimum measurements in the parentheses) is perhaps not fully adult.

Sciuropterus. FLYING SQUIRRELS.

Mr. Anderson says: "Flying Squirrels were reported as occurring at the Indian village of Tahltan, twelve miles up the river from Telegraph, but we were unable to secure specimens."

6. **Sciurus (Tamiasciurus) hudsonicus vancouverensis** *Allen*. VANCOUVER CHICKAREE.

Sciurus hudsonicus vancouverensis ALLEN, Bull. Am. Mus. Nat. Hist., III, 1890–91, 165. Nov. 14, 1890. Duncans, Vancouver Island, B. C.

A single specimen, in summer pelage, was collected at Wrangel, Alaska, June 29, and 14 others, nearly in full winter pelage, were taken on Kupreanof Island, near Wrangel, November 5–15.

In the November series the ventral surface in many of the specimens is dark gray, the hairs being plumbeous at the base, then whitish banded near the tip with black, this being the coloration of the winter dress; but many of the specimens still

show a more or less strong fulvous wash on the lower parts, especially over the pectoral and axillary regions, due to portions of the summer coat still remaining, the moult into winter dress not having been completed.

The 14 November specimens from Kupreanof Island measure as follows: 8 males, total length, 312 (291–325); tail vertebræ, 122 (104–134); hind foot, 51 (49–52); ear, 24 (23–26): 6 females, total length, 309.5 (296–321); tail vertebræ, 122 (115–127); hind foot, 50 (49–51); ear, 23 (22–24).

These specimens appear to be distinctly referable to *vancouverensis*, hardly differing in size or color from Vancouver Island examples.

7. **Sciurus (Tamiasciurus) hudsonicus baileyi** *Allen*. Bailey Chickaree.

Sciurus hudsonicus baileyi Allen, Bull. Am. Mus. Nat. Hist., X, 1898, 261. July 22, 1898. Bighorn Mountains, Wyoming; altitude, 8400 feet.

Represented by 47 specimens taken at Telegraph Creek, July 15 to August 15; 2 taken at the head of Shesley River, September 1 and 6; 6 taken on Level Mountain, September 13–19; and 2 on Raspberry Creek, Oct. 5 and 8; making a total of 57 specimens. Greatly to my surprise, they appear to be referable to *S. h. baileyi*, from Alberta specimens of which they do not very appreciably differ. They are hence quite different from *S. h. petulans* Osgood, of which I have several topotypes for comparison, being much paler and grayer in post-breeding pelage, with the tail fringed with yellowish white instead of deep yellow as in *petulans*.

In this large series of specimens, practically all in summer pelage, there are several that depart greatly in coloration from the average or normal phase, an adult male (No. 19874) from Telegraph Creek, August 5, being as red, and of nearly the same shade of red, as average August specimens of *S. h. loquax* taken in New York or New Jersey; while a young male (No. 19868), taken July 30, at the same locality, is also easily matched by specimens of corresponding age from New York.

These are pale yellowish red instead of olivaceous gray, varied slightly with brownish red, which is the average color of the summer pelage in the Telegraph Creek series.

Fully adult specimens (young of the year being excluded) measure as follows: 16 males, total length, 319 (311–325); tail vertebræ, 128 (120–138); hind foot, 50 (48–51); ear, 25 (23.5–26.5): 8 females, total length, 319 (306–324); tail vertebræ, 124.6 (110–135); hind foot, 49.2 (49–50); ear, 24.6 (23–26).

Mr. Anderson says this squirrel was "abundant among the pines, where it could frequently be seen feeding upon the pine nuts or carrying cones to its burrow beneath some tree."

8. **Eutamias caniceps** *Osgood.* GRAY-HEADED CHIPMUNK.

Eutamias caniceps OSGOOD, N. Am. Fauna, No. 19, Oct. 6, 1900, 28. Lake Lebarge, Northwest Territory, Canada.

This chipmunk is represented by 41 specimens, all taken at Telegraph Creek, July 13–September 15, except 2 from Level Mountain, September 10, and 1 from Raspberry Creek, October 5. Of these 41 specimens 24 are males and 17 females, of which latter only two give evidence of having recently nursed young. Of the whole series not more than six or eight can be considered as adult, by far the larger part not having fully acquired their permanent premolars. None of the males exceed a total length of 206 mm., the greater part falling between 195 and 200, with the tail vertebræ ranging from 86 to 92 mm., the hind foot 32, and the ear 15 mm. The two breeding females measure respectively: Total length, 205 and 215; tail vertebræ, 90 and 97; hind foot, 32 and 34; ear, 15.5 and 17. Several other females, though evidently not fully adult, range in total length from 211 to 213 mm.

This chipmunk, recently described by Mr. Osgood from Lake Lebarge, N. W. T. (N. Am. Fauna, No. 19, Oct., 1900, p. 28), is quite different in coloration from *Eutamias borealis*, being much grayer, with the central area of the tail below much paler. A comparison of several topotypes of *caniceps* with Telegraph Creek specimens shows that the latter are

indistinguishable from *caniceps*. Osgood found it ranging northward from Lake Lindeman to Fort Selkirk; to the southward and eastward it is abundant in the Telegraph Creek region, where Mr. Stone first obtained several immature specimens in the summer of 1897.

Mr. Anderson says: "The little chipmunk, of which a considerable number was secured near Telegraph Creek, was most always to be found about the talus piles and other rocky places, where it feeds upon the seeds of the sabis berry and a small red berry which grows on a little plant close to the ground in dry places." At the head of the Shesley River no specimens were taken, but several were observed in the deep cañon. The two specimens taken on Level Mountain "were the only ones seen there."

9. **Citellus erythrogluteius** (*Richardson*). RED-THIGHED GROUND SQUIRREL.

Arctomys parryi, var. B. *erythrogluteia* RICHARDSON, Faun. Bor.-Amer., I, 1839, 161. Head of Elk River, Rocky Mountains, Lat. 57° N.

Mr. Anderson states that no spermophiles are found in the immediate vicinity of Telegraph village, but a series of 43 was taken on two trips made to Summit, at the head of Telegraph Creek (twelve miles north of Telegraph) July 31 (21 specimens) and August 9 (22 specimens). Another series of 16 specimens was taken on the headwaters of Shesley River, August 23–September 2, where "their burrows could be seen everywhere, but most commonly on hillsides and in little valleys where the earth was soft and not too moist." Both series consist mainly of young-of-the-year, and together show the changes of pelage with season in both the adult and young.

Breeding females in worn pelage, taken July 31, have the general color above gray, washed slightly with brownish over the median area of the back, and mottled with small squarish whitish spots; the whole top of the head, as far back as the posterior border of the ears, dull chestnut brown, brighter and more chestnut anteriorly; cheeks, from below the eyes posteriorly to a little behind the ears, pale yellowish brown;

fore limbs, sides of the shoulders, sides of body and ventral surface grayish white with a faint yellowish tinge, with a tendency to yellowish rust-color on the chest and mid-line of the ventral surface, in part due apparently to the coming in of the new fall coat; tail above gray, broadly fringed with yellowish white, and with a broad subapical bar of black; below, the central area is dull chestnut brown, fringed and tipped as above; upper surface of fore and hind feet pale yellowish gray.

Young specimens, one-fourth to one-half grown, taken at the same place and date, are strikingly like the above-described females, except that the pelage is finer and more woolly; the dorsal area is a little darker or more dusky, with no rufous tinge; the sides of the neck, shoulders, and fore limbs are washed with pale buff; the ventral surface is almost wholly dusky gray, the hairs being for the most part dusky plumbeous, lightly tipped with soiled whitish; tail and feet as in the adults; top of head and nose similar in respect to the extent of the brown area, but the colors are paler.

In the series taken at the same locality August 9 (ten days later) the pelage is much fuller and the colors are much brighter, and the average size of the young-of-the-year has greatly increased. Some of the old males appear to have nearly acquired the full post-breeding dress, at least as regards coloration, though the pelage would still doubtless have appreciably increased in length and fulness. The ground color of the whole dorsal area is now dark iron-gray, or dusky gray, prominently blotched with small squarish spots of white, the hairs individually being dusky at base, centrally ringed with ashy, subapically with black, and tipped with whitish, with which are interspersed many longer wholly black hairs. The top of the nose, as far back as the middle of the eyes, is a bright rusty chestnut; the sides of the neck, shoulders, forearms and thighs and the whole ventral surface extending well up on the sides, are deep rusty ochraceous; the upper surface of the fore and hind feet is deep ochraceous, and the central area of the lower surface of the tail is a much deeper, richer chestnut brown than in the breeding specimens. The larger

of the young-of-the-year specimens are from two-thirds to practically full grown, and differ scarcely at all from the post-breeding pelage of the adults, except that perhaps the sides and the ventral surface are a little paler.

The contrast between these two series, taken only ten days apart, at the same locality, is surprisingly marked, especially when the most advanced adults and largest young-of-the-year of the last set are contrasted with the breeding females and half-grown young of the first set.

The series taken at the head of the Shesley River, two to three weeks later, are quite similar to the more advanced of the August 9 series from Summit, at the head of Telegraph Creek. All of the Shesley River specimens, however, have acquired the winter pelage, while many of the August 9 specimens are still in change, and some are still almost wholly in the worn, faded, breeding pelage.

Most of the 59 specimens in the present collection are young-of-the-year; 11 of the females, however, give evidence of having suckled young; and 7 of the males are obviously adult. The 18 unquestionably adults measure as follows: 7 males, total length, 334 (318–349); tail vertebræ, 86 (75–92); hind foot, 52 (47–56); ear, 11.4 (11–12): 11 females, total length, 324 (308–339); tail vertebræ, 86 (78–100); hind foot, 50.4 (48–54); ear, 11.5 (9–13).

In size and proportions this species closely resembles *Citellus columbianus*, which it also more nearly resembles in general coloration than it does most members of the *parryi* group. It is, however, less strongly colored throughout, and has the central area of the lower surface of the tail rufous instead of gray; besides, it is much smaller and differs strikingly in cranial characters.

Mr. Osgood's *S. empetra plesius* is very closely related to, if not identical with, what is here recognized as *erythrogluteius* Richardson (*Arctomys parryi* var. B. *erythrogluteia* Richardson), the type locality of which is "the Rocky Mountains, near the sources of the Elk River, in latitude 57°." This is very near the localities at which my present large series of specimens was collected; and there is reason to suppose that

its range may extend northwestward to Lake Bennett, the type locality of *plesius* Osgood. Several topotypes of *plesius* (Lake Bennett, June 18–22) are intermediate in coloration between faded July specimens (July 31) and dark September specimens in fresh pelage from Shesley River, as would be expected from the dates of collecting.

Citellus columbianus seems to be specifically distinct from the more northern and very much larger spermophiles constituting the *C. parryi* group, differing greatly in general coloration, especially in the central area of the underside of the tail being gray instead of uniform reddish brown; also in relatively longer tail, much smaller size (fully one-third less), and in the narrower and slenderer skull, etc.[1]

10. **Citellus stonei,** sp. nov. WRANGEL GROUND SQUIRREL.

Type, No. 20775, adult (♂ ?), Wrangel, Alaska, June, 1902; collected by Andrew J. Stone, for whom the species is named.

The type and only specimen of this species is a flat skin (without flesh measurements) with an excellent adult skull, and is apparently a male, and in excellent pelage.

Above gray, suffused with rufous, especially on the median dorsal area, the rufous increasing in intensity on the lower back and rump, where it almost becomes the prevailing tint; the hairs individually are blackish basally, then broadly banded with bright buff (almost golden apically), then narrow-banded with dark brown tinged with rusty, and broadly tipped with whitish, more or less suffused with rufous over the median and posterior portions of the dorsal area; with these hairs, constituting the bulk of the pelage, are much longer

[1] A comparison of a series of five specimens of C. *columbianus* from Moscow, Idaho (hence topotypes), with six specimens from Banff, Alberta, shows that the latter differ from the former in certain features of the skull, although the two series are closely similar in size, proportions, and coloration, except that the Banff specimens are a little paler. The skull in the Banff specimens, while but slightly larger in linear dimensions, is much heavier and more massive, with the zygomata especially thickened, the malar being nearly twice as massive as in true *columbianus*, while the antorbital foramen is sharply triangular instead of circular, with the peg-like process forming its lower border much more heavily developed and angular, and the postpalatal border is more produced posteriorly. For this form I propose the name

Citellus columbianus albertæ, subsp. nov.

Type, No. 15539, Am. Mus., ♂ ad., Canadian National Park, Alberta, Canada, August 16, 1899; coll. G. F. Dippie.

Collector's measurements of type: Total length, 321; tail vertebræ, 108; hind foot, 57 mm. Three other specimens in the series slightly exceed these dimensions. Skull, total length, 52; zygomatic breadth, 33.

hairs which are apically wholly black. Front half of the top of the head rusty cinnamon, the posterior half rusty, strongly varied with blackish; sides of face and neck clear gray; fore limbs lighter gray with a faint buffy wash; sides of shoulders suffused (mostly beneath the surface) with pale rufous; thighs pale rufous, with the longer hairs banded subapically with black and with long white tips, mixed with a few wholly black-tipped hairs; upper surface of hind feet deep rusty yellow or orange, the edges and lower surface clothed with gray or yellowish gray hairs; front and sides of nose, under side of head, throat, breast, and inside of fore legs whitish, the base of the pelage blackish plumbeous; rest of ventral surface washed rather strongly with pale rufous; tail above at extreme base tinged with rusty, the rest gray, with a faint tinge of rufous apically at the base of the hairs, the sides with a narrow band of black and a broad fringe of pale yellowish white; a broad (25–30 mm.) subapical band of black; tail below with the central area pale brownish rusty, increasing in intensity apically, with a broad subapical band of black and a yellowish white fringe.

Measurements (from flat skin, apparently much shrunken). Total length, 350; tail vertebræ, 100; hind foot, 59.

Skull. — Large, equal in dimensions to large skulls of *Citellus barrowensis* and *C. parryi*, but general form less broad anteriorly and rostral portion more elongated, giving quite a different contour as seen from above; interorbital area and nasals narrower, breadth across base of premaxillæ one-eighth to one-seventh less; antorbital foramen oval, very broad and depressed. Total length, 59; greatest zygomatic breadth, 37; nasals, 22, terminating about evenly with the premaxillæ; width of nasals at base, 5, as against 6 to 7 in *barrowensis* and *parryi*.

Citellus stonei is easily distinguished from *C. erythrogluteius* (and *C. plesius* if different) through its immensely larger size and very different coloration; and also from *C. osgoodi*, *C. barrowensis* and *C. parryi* [1] in coloration, as well as in cranial characters, as above detailed. In coloration it bears very little resemblance to either of the three species last mentioned, though perhaps most approaching *C. osgoodi* in general features.

[1] In the series of C. *parryi* collected by Mr. George Comer for this Museum in the vicinity of Repulse Bay are several specimens that fulfil all the requirements of Richardson's *Arctomys parryi*, var. γ, *phæognatha*, reputed to have been based on a specimen said to have been "also brought from Hudson's Bay, but the particular district not mentioned" (Fauna Bor.-Amer., I, p. 161) and described as "characterized chiefly [in comparison with *parryi*] by a well-defined deep, chestnut-coloured mark under the eye." Two out of the Comer series of nine specimens are thus marked and a third shows a trace of the same mark, which is apparently a feature of season or of very high coloration.

11. **Marmotta caligata** (*Eschscholtz*). HOARY MARMOT.

Arctomys caligatus ESCHSCHOLTZ, Zoöl. Atlas, II, 1829, p. 1, pl. vi. Near Bristol Bay, Alaska.

A series of 13 specimens was taken on the Cheonnee Mountains, July 21–24, of which four were old nursing females, one an adult non-breeding female, three half-grown and five quarter-grown young. There are also two adults from Shesley River, taken August 23 and 27, and an old male from Level Mountain, taken September 16, making a total of 16 specimens.

The quarter-grown young from the Cheonnee Mountains, in the first, soft, woolly pelage, differ little in general pattern of coloration from the adults from the same locality, but the lower back is less varied with black. The pelage in all of the adults is thick and heavy but more or less worn, and there is considerable individual variation in the amount of black in the dorsal pelage. Generally from the nape posteriorly to the middle of the back, including the shoulders and sides, the color is whitish gray, and the rest of the dorsal surface blackish varied with rusty brown; but in one of the Shesley River specimens the prevailing color above over the anterior half of the body is black varied with gray.

A single adult male from Level Mountain measures as follows: Total length, 792; tail vertebræ, 210; hind foot, 100; ear, 32. Five breeding females (four from the Cheonnee Mountains and one from Shesley River), measure: Total length, 668 (659–672); tail vertebræ, 189 (180–200); hind foot, 95 (93–96); ear, 34 (33–37).

Mr. Anderson states that these animals were first met with in the Cheonnee Mountains, they not being found in the immediate neighborhood of Telegraph Creek. "In the Cheonnees, as elsewhere," he says, "these animals are found in dry, rocky places. They are very wary and shy." On Level Mountain, September 8–21, their "burrows were frequently seen in the numerous rocky localities, but the animals were undoubtedly beginning to hibernate. The whistle of one was heard on September 15, and Dennis [the Indian helper] shot

a specimen September 16." In the neighborhood of Shesley River camp none was found, but two specimens were brought in from a distance.

12. **Mus musculus** *Linnæus.* House Mouse.

Three specimens, Telegraph Creek, August 2, 6, and 7. They were trapped about the buildings in the village of Telegraph.

13. **Peromyscus sitkensis** *Merriam.* Sitka White-footed Mouse.

Peromyscus sitkensis Merriam, Proc. Biol. Soc. Wash., XI, July 15, 1897, 223. Sitka, Alaska.

Eight specimens (2 adults, 1 young adult, 5 half to two-thirds grown young), from Wrangel, June 27–30, and two young adults from Kupreanof Island, November 8. In six of the oldest specimens the tail averages just one-half the total length, varying from a little less to a little more than half.

According to Mr. Anderson's notes, these specimens "were trapped under rotten logs in the higher and dryer places."

14. **Peromyscus arcticus** (*Mearns*). Arctic White-footed Mouse.

Hesperomys leucopus arcticus Mearns, Bull. Am. Mus. Nat. Hist., II, No. 4, 1890, 285. Feb. 20, 1890. Fort Simpson, Mackenzie River, Canada.

All of the white-footed mice from the interior are referred to *P. arcticus*, except a single specimen from the Cheonnee Mountains which appears referable to *P. oreas* Bangs. The series numbers altogether 292 specimens, collected as follows: Telegraph Creek, 272 specimens, July 11–August 17; Cheonnee Mountains, 4 specimens, July 22 and 23; Shesley River, 3, August 23 and 24; Level Mountain, 3, September 12–15; Raspberry Creek, 10, October 8–12. About four-fifths of the series consists of young-of-the-year and 'young adults.' Of the large number of females only about 50 give evidence of

having suckled young, or show by their worn teeth that they were fully adult. As of interest in showing the wide range of variation in size and proportions in breeding females, the collector's measurements of 40 specimens, all from Telegraph Creek, and including all of the breeding females in the series of 265 specimens, are tabulated below in the order of size, from which it will be seen that the total length ranges in old adults with well-worn teeth from about 180–190 mm., with the tail length ranging from about 82 to nearly 90; while the young females, with generally wholly unworn teeth and many of them still in the pelage of immaturity, range from about 165 to 175, with a tail length of from about 72 to 80. It will also be noted that the ratio of tail length to total length is considerably higher in the larger and older specimens than in the younger and smaller ones, ranging from about 44 to 48 in the former and 42.5 to 46 in the latter. It thus appears that the length of the tail, as perhaps would be expected, increases more than the length of the head and body between the period of breeding age and complete maturity or old age.

An examination of the skulls of these specimens shows that while this wide range of variation in size may be referred in large part to age, the element of individual variation also plays an important part, since one of the largest specimens in the series has the teeth unworn and the bones of the skull not firmly united, while on the other hand, several of the smallest specimens have the teeth greatly worn and the skull sutures firmly closed.

There is a much smaller proportion of adult males in the collection than of adult females, but so far as the material goes, there is no appreciable sexual difference in size.

The type locality of *Peromyscus arcticus* was Fort Simpson, on the Mackenzie River, about half way between Fort Liard and Fort Norman. Fortunately the American Museum collection contains a small series from each of these points, and also from Hell Gate and Telegraph Creek, taken by Mr. Stone in 1897 and 1898, numbering altogether about 30 specimens. These, with the collection now under special notice, represent the species by specimens taken in April, May, July,

August, September, and October. The April and May adults, and the September and October specimens are much darker, or more blackish, and less faded than the July and August specimens, which are in moult and in thin pelage in comparison with the thick, soft, and longer coat of the April-May and September-October examples.

The young are born, judging from the present material, mainly during July and the first half of August; April and May females not yet having begun to nurse young, while in September and October the nipples have become so shrunken and the mammæ so heavily enclosed in soft fur that it is difficult to distinguish males from females by an examination of the skins. During the nursing period, and until the completion of the moult, a bare space surrounds the nipples, indicating, usually at a glance, the females that have recently nourished young.

Mr. Anderson states: "Near Telegraph, white-footed mice were trapped in every kind of place to be found, wet or dry, talus or level terrace." At the camp at timber-line on the Shesley River they "were not common," and only three were obtained on Level Mountain; but they were very abundant at the camp on Raspberry Creek.

External Measurements of 40 Breeding Females of *Peromyscus arcticus*.

Mus. No.	Total length.	Tail vertebræ.	Hind foot.	Ear.	Ratio of tail vert. to total length.
20150	189	86	20.5	18	45.5
20352	187	90	20	18	48
20168	186	83	21	18.5	45
20356	185	87	20	18	47
20204	185	83	21	19	45
20334	184	87	20.5	20	47
20109	184	81	21	18.5	44
20116	183	81	22	19	44.3
20261	182	85	20	18	46.7
20294	181	85	20.5	20	47
20274	181	84	20	19.5	46.3

EXTERNAL MEASUREMENTS—*Continued.*

Mus. No.	Total length.	Tail vertebræ.	Hind foot.	Ear.	Ratio of tail vert. to total length.
20296	179	82	20.5	19.5	45.8
20242	179	82	21	19	45.8
20215	179	81	20	18	45
20221	178	82	19.5	18	46
20344	178	82	21.5	18	46
20308	178	80	20.5	18.5	45
20280	177	80	21	19	45
20118	177	78	21	18	44
20108	176	86	21	18	48.8
20183	176	78	21	20	44.3
20120	176	75	22	20	42.6
20184	175	78	20	18	44.6
20249	175	78	21	18	44.6
20117	175	76	19	18.5	43.4
20100	174	80	20	19	46
20281	174	78	20	18.5	45
20167	174	77	20	18	44.3
20246	172	74	20	19	43
20158	172	74	20	19	43
20324	171	78	19.5	18	45.6
20186	171	75	20	18	43.9
20219	171	72	21	18	42
20205	170	78	20	19	46
20345	170	75	19	19	44
20263	170	74	20	17 (?)	43.5
20157	169	72	20	19	42.6
20133	167	77	21	19	46
20122	167	74	20	18	44.3
20269	163	71	20	18	43.5
Average....	176	78.9	20.4	18.6	44.8

7 specimens have a total length of 184 or more.
16 " " " " " 174 or less.
17 " " " " between 174 and 184.
8 " " a tail length of 84 or more.
9 " " " " " 74 " less.
23 " " " " " between 74 and 84.
Ratio of tail vertebræ to total length, 42 to 48.
22 specimens have a tail ratio of 45 or above.
18 " " " " less than 45.

15. **Peromyscus oreas** *Bangs*. Bangs White-footed Mouse.

Peromyscus oreas Bangs, Proc. Biol. Soc. Wash., XII, 84, March 24, 1898. Mount Baker Range, 49th parallel, British Columbia; altitude, 6500 feet.

A single specimen, Cheonnee Mountains, July 22, a young male with the following measurements: Total length, 189; tail vertebræ, 100; hind foot, 23; ear, 19. In color and character of pelage it closely resembles young adults of *P. sitkensis*, but the skull is very different from the skull of that species. Mr. Osgood (N. Am. Fauna, No. 19, Oct. 1900, p. 32) has recorded *P. oreas* from Skagway, Glacier, Summit, Bennett, Caribou Crossing and other points near the head of the Yukon, showing that its range extends to the northward much beyond the Telegraph Creek region, where, however, it seems to be rare, as only one of the three hundred specimens of *Peromyscus* taken here proves referable to this species.

16. **Neotoma cinerea saxamans** (*Osgood*). Northern Bushy-tailed Rat.

Neotoma saxamans Osgood, N. Am. Fauna, No. 19, Oct. 6, 1900, 33. Bennett City, head of Lake Bennett, B. C.

Represented by 46 specimens, taken as follows: Telegraph Creek, 41 specimens, July 17 and 18, and July 27 to August 15; Level Mountain, 2 specimens, September 10 and 21; Raspberry Creek, 2 specimens, October 9 and 11; Sheep Creek, 1 specimen, October 14. Of these 8 are breeding females, and 3 are fully adult males; the others are apparently all young-of-the-year, and vary from about quarter-grown to full-grown. The young in first pelage are, above, blackish gray; below, with a large pure white pectoral area, and the rest of the underparts with the fur plumbeous tipped more or less with whitish, the white particularly conspicuous along the median line, and expanding to form a small clear white anal patch. In many specimens of this age the whole ventral surface is superficially pure white, with the underfur more or

less plumbeous. Later the amount of white below increases till in half-grown specimens the whole ventral surface is white, with the pelage on the lateral third of the ventral area on either side, more or less plumbeous basally. The color of the upper parts is still dusky gray. When about full-grown the yellowish brown of the adult pelage begins gradually to appear.

The adults in full pelage are yellowish olivaceous brown above, strongly washed with blackish, through the abundance of long black-tipped hairs intermixed with the general pelage; below pure white to the base of the hairs, with a tendency to a buffy wash over the middle of the abdominal area. In the worn, faded pelage of the breeding season the upper surface is suffused with pale cinnamon brown.

Eleven adults measure as follows: 3 males, total length, 409 (399–425); tail vertebræ, 171 (167–180); hind foot, 47.3 (46–49); ear, 32: 8 breeding females, total length, 370.5 (358–380); tail vertebræ, 156 (147–165); hind foot, 44.3 (42–46); ear, 30 (28–31).

Six adult skulls, three males and three females, measure: Total length, 51.5 (49–53); zygomatic breadth, 26. 4 (25.4–27.2); interorbital breadth, 5 (4.8–5.2); nasals, 21 (20–22).

Neotoma cinerea saxamans differs from *N. c. drummondi* in being paler and of a more yellowish gray brown above, with also the upper parts more strongly varied with blackish. A comparison of the present material with a small series of specimens from the vicinity of Banff, Alberta, shows that the alleged cranial differences mentioned in the description of *Neotoma saxamans* are of very slight importance, adult and strictly comparable skulls from Banff and Telegraph Creek being indistinguishable as regards the form of the nasals, the maxillary branch of the zygoma, and the more or less openness of the spheno-palatine vacuities. There is apparently a slight average color difference between true *drummondi* and the more northern bushy-tailed rats, and also in the cranial characters indicated by Osgood, but the Telegraph Creek series presents intermediates, and shows that all of these features are subject to considerable individual variation.

The color of the incisors, given also as a character, is very variable, ranging from pale yellow to deep yellow. The single specimen of *saxamans* of which external measurements are given, from "a dry skin," considerably exceeds in size any of the specimens from the Telegraph Creek region, but the cranial measurements show that this difference is apparent rather than real.

At Telegraph Creek the bushy-tailed rats were "fairly abundant"; they were "trapped in the talus just beneath the cliffs above Telegraph, and in several other rocky places." At the camp at the head of the Shesley River (at timber-line) none was secured and only one was seen. Only two were taken on Level Mountain. Two were trapped at the camp on Raspberry Creek, "beside a large rock in a dry flat, away from timber."

17. **Evotomys wrangeli** *Bailey.* WRANGEL RED-BACKED MOUSE.

Evotomys wrangeli BAILEY, Proc. Biol. Soc. Wash., XI, May 13, 1897, 120. Wrangel Island, Alaska.

Wrangel Island, 18 specimens (topotypes), June 25 to July 7, of which 6 are adults, 7 are nearly full-grown young, and 5 about half-grown. Four adult females measure as follows: Total length, 145 (141–147); tail vertebræ, 33 (31–34); hind foot, 19.6 (19–20.5); ear, 14.2 (13–15). The two adult males are smaller, measuring respectively: Total length, 136, 138; tail vertebræ, 30, 33; hind foot, 19.5, 20; ear, 15, 14.5. In coloration they exactly resemble the females, showing that they are fully adult. The nearly full-grown young (total length 129–138) are much duller and darker, with much less red on the back.

18. **Evotomys dawsoni** *Merriam.* DAWSON RED-BACKED MOUSE.

Evotomys dawsoni MERRIAM, Am. Nat., XXII, July, 1888, 649. Finlayson River, Northwest Territory, Canada.

Represented by 67 specimens, as follows: Telegraph Creek, 5 specimens, July 13, and August 4, 7, and 17; Cheonnee

Mountains, 11, July 21–25; Level Mountain, 42, September 10–21; Raspberry Creek, 9, October 6–13.

The type of *Evotomys dawsoni* was from the Finlayson River, a northern fork of Liard River. The present series added to the 16 specimens taken by Mr. Stone at Fort Norman, at Fort Liard, at Hell Gate on the Liard River, and at other localities in the same general region, forms a series of 83 specimens collected at various dates from the middle of July to the middle of December. There is also in the collection the series of 35 specimens obtained by the Stone Expedition of 1901 on the Kenai Peninsula, making about 120 specimens referable to this species. The adults are very uniform in coloration except three taken on the Liard River December 7–11, 1897,[1] and one at Dawson; these differ from all the others in their much lighter, yellowish brown color, and represent apparently the midwinter coat, which is usually lighter than that of late summer and early fall. There can be little doubt that these specimens are referable to the true *E. dawsoni* from Finlayson River and Fort Liard. Yet they fall far below the average size as given by Bailey (Proc. Biol. Soc. Washington, Vol. XI, 1897, p. 121), based on Yakutat specimens, of which he gives the average of eight specimens as: "Total length, 144; tail vertebræ, 33; hind foot, 20."

The series from the upper Liard River region contains many specimens with well-worn teeth and very mature-looking skulls, yet only 5 attain a length of 140 mm., the average of 20 of the largest specimens of the series falling slightly below 130, with an average length of tail of about 33, but with the hind foot 19 instead of 20. Thus 13 specimens (9 males and 4 females) from Level Mountain measure as follows: Total length, 129 (123–141); tail vertebræ, 32.7 (29–38); hind foot, 18.6 (18–19.5); ear, 15.6 (14–16.5). The largest 13 specimens from the Kenai Peninsula (6 males and 7 females) are somewhat larger, having a total length of 137 (133–140); tail vertebræ, 32.6 (31–38); hind foot, 19 (18–

[1] Formerly (this Bulletin, Vol. XII, 199, p. 5) erroneously referred to *E. alascensis*, as shown on reëxamination, in the light of more abundant material. The supposed cranial differences mentioned prove to be due to the immaturity of the single complete skull available for examination.

19.5). These latter measurements are very close to those given by Dr. Merriam for his *E. orca* from Prince William Sound.

It may prove that the larger Alaska coast specimens (Yakutat north to Alaska Peninsula) are better referable to *E. dawsoni orca* than to *E. dawsoni.*

19. **Microtus mordax vellerosus** (*Allen*). Woolly Vole.

Microtus vellerosus Allen, Bull. Am. Mus. Nat. Hist., XII, 1899, 7. March 4, 1899. Upper Liard River, Northwest Territory, Canada.

Microtus cautus Allen, *ibid.*, Hell Gate, Liard River.

Represented by 53 specimens collected as follows: Telegraph Creek, 38 specimens, July 11 to August 8, and October 18–20; Cheonnee Mountains, 1, July 24; Tahltan River, 1, August 18; Shesley River, 1, August 27; Level Mountain, 6, September 11–19; Raspberry Creek, 5, October 4–6; Sheep Creek, 1, October 14. About three-fifths are adult, of which only 7 reach or exceed 190 mm., in total length. Of the series of nearly 40 specimens from Telegraph Creek the 27 adults (6 males and 21 females) measure as follows: *Males:* Total length, 175.3 (158–190); tail vertebræ, 61.3 (52–70); hind foot, 20.8 (19–21); ear, 14 (13–15). *Females:* 176 (160–195); 60.6 (50–70); 21 (19.5–21.5); 14 (13–15). Nine old adults (7 males and 2 females) from the other localities measure slightly larger, as follows: Total length, 182.5 (168–202); tail vertebræ, 65 (60–70); hind foot, 20.7 (19.5–22); ear, 14 (13–15).

The series well illustrates the pelages of adults from July to October, and of the young in various stages of growth. The adults vary considerably in the amount of yellowish brown suffusing the dorsal surface, even among specimens taken at the same season and locality. July specimens have this tint brighter and stronger, often reddish brown, than September and October specimens, which are grayer and more yellowish brown, but some October specimens have a rufescent brown cast, while others are much paler and grayer. The type of *M. vellerosus* is a very gray specimen from the upper Liard

River, taken the last of November. It is the grayest specimen of the whole series; but several October specimens from Telegraph Creek very closely resemble it. My *M. cautus* (see this Bulletin, Vol. XII, 1899, p. 7) is a May specimen, also from Liard River, and though more yellowish brown on the back, is easily matched by the brighter specimens of the October series, and is, as stated by Mr. Bailey[1] (N. Am. Fauna, No. 17, 1900, p. 48, footnote), a phase of *vellerosus*.

The present large series shows that *vellerosus* is rather darker colored and more rufescent than *mordax*, and somewhat smaller, the hind foot averaging 21 mm., instead of 22, and the ear 14 instead of 15. Six specimens of *mordax* (the type and 5 topotypes) measure (*cf.* Merriam, N. Am. Fauna, No. 5, 1891, p. 62) as follows: Total length, 184 (180–200); tail vertebræ, 67.3 (63–77); hind foot, 22 (21–23). Seven adults from Amador County, California, collected and measured by Mr. W. W. Price, range as follows: Total length, 193 (181–202); tail vertebræ, 66.2 (57–67); hind foot, 22.9 (20–25); ear, 15.1 (14–16). *Microtus vellerosus* seems well-entitled to stand as a northern subspecies of *M. mordax*.

20. **Microtus drummondi** (*Aud. & Bach.*). Drummond Vole.

Arvicola drummondi Aud. & Bach., Quad. N. Am., III, 1853, 106, pl. cxxxv. "Valley of the Rocky Mountains."

Microtus drummondi Bailey, N. Am. Fauna, No. 17, June, 1900, 22. "Type locality, Rocky Mountains, vicinity of Jasper House, Alberta."

Represented by 39 specimens, taken as follows: Cheonnee Mountains, 3 specimens, July 22–25; Telegraph Creek, 1, July 27; Shesley River, 4, August 25 to September 1; Tahltan River, 1, August 18; Level Mountain, 30, September 10–21. Only 12 are fully adult, 7 of which are males and 5 are females; all of the adults, except one, are from Level Mountain, and

[1] In his comment on these species he has transposed the names *vellerosus* and *cautus;* his remarks respecting the former relate to the latter, and *vice versa.*

measure as follows: 7 males, total length, 151 (146–162); tail vertebræ, 41.3 (40–46); hind foot, 18.4 (18–19); ear, 12.7 (12–13): 5 females, 155 (153–158); 42 (40–44); 18.6 (18–19.5); 13.2 (13–14).

There is a wide range of individual variation in color, both July and September specimens varying above from a dark gray brown, slightly suffused with yellowish brown, to darker brown strongly suffused with chestnut; the underparts may be pure gray or strongly washed with buffy, especially in fall specimens after the moult.

It is of interest to note that 30 of the 39 specimens of this species were taken on Level Mountain and only one at Telegraph Creek; while in the case of *M. m. vellerosus* 38 out of 52 specimens were taken at Telegraph Creek, and only 6 on Level Mountain, showing that the two forms occupy different areas of abundance.

My *Microtus stonei* (this Bulletin, Vol. XII, 1899, p. 5), based on a specimen from the head of Liard River, is unrepresented in the present collection. The present large series of *M. drummondi*, together with a series of over 20 specimens from northern Alberta, furnish ample means for the comparison of *M. stonei* with *M. drummondi*. Instead of "the type of *M. stonei*" being "indistinguishable from typical *drummondi*" (*cf.* Bailey, N. Am. Fauna, No. 17, 1900, p. 23), it proves to be cranially widely different, although externally closely resembling *drummondi*. In *M. stonei* the rostral portion of the skull, including the interorbital region, is very narrow and greatly elongated, in strong contrast to the short, broad form of this portion of the skull in *M. drummondi*, and the incisive foramina are correspondingly long and narrow. In *stonei* the superior aspect of the interorbital region has also a deep longitudinal groove never present in *drummondi;* and the maxillary branch of the zygoma is much narrower; the angular process of the lower jaw is longer, slenderer, and more pointed. The form of the posterior loop of the last upper molar is also distinctly different. *M. stonei* may therefore be regarded as specifically distinct from *M. drummondi.*

21. **Microtus macrurus** *Merriam.* OLYMPIC VOLE.

Microtus macrurus MERRIAM, Proc. Acad. Nat. Sci. Phila., 1898, 353. Oct., 1898. Lake Cushman, Olympic Mountains, Washington.

A single specimen, a 'young adult' male, from Kupreanof Island, southeastern Alaska, taken November 10. Total length, 165; tail vertebræ, 61; hind foot, 20; ear, 14. Above very dark gray brown, or blackish brown, with an almost imperceptible yellowish suffusion; below dark gray, the longer hairs tipped with whitish.

22. **Fiber spatulatus** *Osgood.* NORTHWEST MUSKRAT.

Fiber spatulatus OSGOOD, N. Am. Fauna, No. 19, Oct. 6, 1900, 36. Lake Marsh, Northwest Territory, Canada.

One specimen, an old male, Shesley (Government telegraph station), September 5.

This specimen greatly exceeds the measurements given for *F. spatulatus*, but agrees with the description of this species in all other characters. As shown by the massive, heavily ossified skull, the animal was a very old male. The external measurements are: Total length, 583; tail vertebræ, 290; hind foot, 78; ear, 23. Skull: Total length, 68; basal length, 64.5; zygomatic breadth, 43; length of nasals, 24; least width of nasals posteriorly, 3; greatest width anteriorly, 11.2; alveolar length of molar series, 15; length of crown surface, 13. A specimen of corresponding age and sex from Hastings, Westchester Co., N. Y., measures as follows: Total length, 591; tail vertebræ, 274; hind foot, 83. Skull: Total length, 65; basal length, 62; zygomatic breadth, 39.6; length of nasals, 22; least posterior width of nasals, 2.6; greatest anterior width of nasals, 8.6; alveolar length of molar series, 16; length of crown surface of molar series, 15. The Shesley skull thus exceeds in linear dimensions and greatly in massiveness any skull in a very large series of eastern Muskrats; and also exceeds the type specimen of *F. spatulatus* by about 20 per cent. in total length, and about 7 per cent. in the principal skull measurements.

Muskrats, like most other mammals, continue to increase in size after maturity is reached, the skull increasing somewhat in linear measurements and especially in massiveness. The type of *F. spatulatus* is given as "yg. ad.," and no other specimens from the type region are referred to. If the character, "size small," is based on this specimen, this comparative statement should be eliminated, as shown by the following table of comparative measurements, giving the principal dimensions of the seven largest Muskrat skulls in the Museum series of considerably over one hundred specimens. They are all very old examples, and range much above the average, doubtless, for the several forms they represent. This is at least true of the New York and New Jersey series.

Comparative Measurements of Skulls of Muskrats.

Mus. No.	Species.	Sex.	Total length.	Basal length.	Zyg. breadth.	Nasals. Length.	Nasals. Post. width.	Nasals. Ant. width.	Molar series.
98567	Fiber spatulatus.....	♀	—	57	38	21	—	—	14
20768	" "	♂	68	64.5	43	24	3	12	15
16422	" osoyoosensis....	♂	66	63	42	25	2	10	15
16421	" "	♀	65.5	62	41.2	23	2.5	10	16
16204	" zibethicus......	♂	69	65	42	24	3	10	15
16205	" "	♀	69	64.6	41	24	3	10	16
8541	" "	♂	65	62	39.6	22	2.6	8.6	16
15980	" "	♂	68	64	43	24	3	9	16

No. 98567, U. S. Nat. Mus., type of *Fiber spatulatus* Osgood. Lake Marsh, N. W. T. (measurements from Osgood, *l. c.*).

No. 20768, Am. Mus., Shesley, B. C.

No. 16422 and 16421, Am. Mus., Kettle River, B. C., near type locality of *Fiber osoyoosensis*.

No. 16204 and 16205, Am. Mus., Newport, Nova Scotia.

No. 8541, Am. Mus., Hastings, Westchester Co., N. Y.

No. 15980, Am. Mus., Paterson, N. J.

Mr. Anderson says (MS. notes): "On September 5 a single muskrat was shot on the marshy edge of a small lake about a mile from Shesley; another was shot at, but not secured.

Muskrats are not uncommon in many of the small lakes so numerous along the Teslin trail, and more specimens would certainly have been secured had we carried a shotgun on our trip to Level Mountain. . . . On the morning of October 9 I observed a muskrat in a small pond just back of our camp, on Raspberry Creek. I had no means of securing him."

23. **Phenacomys constablei** *Allen.* CONSTABLE VOLE.

Phenacomys constablei ALLEN, Bull. Am. Mus. Nat. Hist., XII, 1899, 4. March 4, 1899. Telegraph Creek, B. C.

Represented by 11 specimens, of which 8 were taken at Telegraph Creek, July 14 to August 13; and 1 each on the Cheonnee Mountains (July 21), Shesley River (September 1), and Level Mountain (September 11). All are females except two, and five of them appear to have suckled young, but only four had attained fully adult size. The five adults measure as follows: Total length, 143.5 (139–148); tail vertebræ, 33 (31–41); hind foot, 17.7 (17–19); ear, 13.6 (13–14).

Phenacomys constablei was based on two specimens collected by Mr. A. J. Stone on Telegraph Creek, August 24, 1897, so that eight of the present series are topotypes. Both of the original specimens were females, one of which was quite young, while the other (the type) had evidently nursed young and was described as adult. The present series, however, shows it was much below the average size of full-grown adults, the total length being only 124 mm., and the tail 31 mm., as against 144 and 33 in fully adult females of the present series. In other respects the original description requires no emendation.

This species must be very rare or of local distribution, as out of over 350 specimens of mice of various species taken at Telegraph Creek only 8 were *Phenacomys*, and only two *Phenacomys* were taken elsewhere, although very large numbers of mice were collected on Level Mountain and at other points.

This species has a close external resemblance to faded summer specimens of *Microtus drummondi*, not only in coloration but in size and proportions, so close, indeed, that it is quite difficult to distinguish the two species by skins alone. The

form of the hind foot — broad and short in *Phenacomys* and long and slender in *M. drummondi* — and certain differences in the size and position of the plantar tubercles, however, will usually suffice for their discrimination. In the reddish brown fall dress, with the underparts more or less tinged with buff (September, October, and November specimens), of *M. drummondi* there is a well-marked contrast in color with July and August specimens of *Phenacomys constablei;* but the adult fall pelage of the latter is not as yet known.

24. **Synaptomys (Mictomys) andersoni,** sp. nov. ANDERSON LEMMING VOLE.

Type, No. 20467, ♀ ad., Level Mountain, northern British Columbia, September 11, 1902; M. P. Anderson.

Above dark brown, faintly suffused with clay color and strongly varied with blackish, the head, including the sides of the nose and cheeks, concolorous with the back; under surface ashy gray, rather sharply defined against the yellowish brown flanks; tail bicolor, the dorsal third blackish, the sides and lower surface dull grayish; upper surface of fore and hind feet blackish brown, the hind feet rather darker than the fore feet; ears small, wholly concealed in the fur.

Total length, 120; tail vertebræ, 25; hind foot, 18; ear, 11.5. Skull: Naso-occipital length, 24.6; basal length, 23; zygomatic breadth, 14.5; mastoid breadth, 11.5; interorbital constriction, 3; length of braincase, 14; length of rostrum (front edge of nasals to braincase), 11; length of nasals, 6; length of incisive foramina, 4.2; length of upper toothrow, 6.6. General form of the skull much as in *S. wrangeli*, but bullæ much more inflated, especially anteriorly, and the posterior loop on the last upper molar much larger, about two-thirds as large as the middle loop; reëntrant angle on outer side of last molar deeper, nearly as deep as in *S. truei*.

Synaptomys andersoni is based on a single adult specimen collected on Level Mountain, northern British Columbia, September 11, and is in heavy fall pelage. Its nearest known geographical representative is *S. wrangeli*, from Wrangel, Alaska, from which it is apparently quite distinct, it in some features more resembling *S. dalli* from Nulato, Alaska. The species is named for Mr. M. P. Anderson, whose very careful field work has so greatly contributed to the success of the Stone Expeditions of 1902 and 1903.

[In a small collection of mammals made by Mr. Frank M. Chapman at Glacier, B. C., in July, 1901, is a single specimen of *Synaptomys* that seems specifically distinct from any previously recognized, and which I take the present opportunity to describe.

Synaptomys (Mictomys) chapmani, sp. nov. CHAPMAN LEMMING VOLE.

Type, No. 16908, ♂ ad., Glacier, Selkirk Range, British Columbia, July 20, 1901; Frank M. Chapman, for whom the species is named.

Above grayish brown, with a slight suffusion of buff, strongest on the front of the head, the whole region in front of the eyes being conspicuously washed with buff; ventral surface dark gray, the plumbeous underfur being slightly tipped with whitish, not sharply defined against the sides; ears large, colored like surrounding pelage; feet dusky grayish brown; tail very short, darker above than below, well pencilled. Side glands in front of hips covered with conspicuously lighter fur, almost whitish.

Total length, 134; tail vertebræ, 21; hind foot, 20; ear (from notch, in dry skin), 11; prominent above the fur. Skull: Naso-occipital length, 26; basal length, 24.5; zygomatic breadth, 15.2; mastoid breadth, 11.5; interorbital constriction, 3; length of braincase, 13.5; length of rostrum (front edge of nasals to braincase), 12.2; length of nasals, 6.6; length of palatal foramina, 5; length of upper toothrow, 7. Compared with *S. andersoni* it is much larger, and the general form of the skull is narrower, with a relatively narrower braincase and more elongated rostrum; the incisive foramina are much longer and narrower, and the audital bullæ much smaller and less inflated; last loop of last upper molar large, as in *S. andersoni*, and the reëntrant angle on the outer border of last lower molar is also strongly marked.

Unfortunately this species is represented only by the type, an old male, taken at Glacier, B. C., by Mr. Chapman in July, 1901. Externally the species seems to be well characterized by its very short tail and large ears, the dark grayish brown color of the upper parts and buffy nose. The narrow skull, elongated rostrum, and small bullæ seem to distinguish it from its more northern allies. The presence of this species in the Selkirks extends considerably to the southward, especially in the West, the previously known range of the subgenus *Mictomys*.]

25. **Lemmus helvolus** (*Richardson*). Golden Lemming.

This beautiful lemming is represented by 43 specimens, collected as follows: Telegraph Creek, 28 specimens, July 31, August 9, and October 17; Level Mountain, 11, September 10–25; Shesley River, 1, August 27; Raspberry Creek, 1, October 11; and 2 without locality. Only about 12 are adult, the others ranging from nursing young to two-thirds grown.

In the adults the anterior half of the upper surface is gray suffused with fulvous, the sides and top of the head and neck being gray or grayish, gradually passing into deep yellowish brown over the shoulders, and thence posteriorly to the tail the color ranges, in different specimens, from ochraceous, or even golden, to ochraceous rufous, and in some to reddish chestnut. (Late September and October specimens have the upper parts lighter or more golden than the August examples.) The flanks are deep ochraceous, varying to orange ochraceous; chin and throat soiled grayish white; rest of the ventral surface ranging in different specimens from deep buff to ochraceous buff. In the half to two-thirds-grown young the head is more heavily suffused with fulvous than in adults, and there is hence less contrast between the anterior and the posterior parts of the dorsal area. Young in the soft, woolly, first pelage are dull brown strongly washed with dark rufous, with nearly the same contrast in color antero-posteriorly as in the adults. In all pelages there is a slight admixture of stiff black or blackish-tipped hairs overtopping the general pelage, varying greatly in abundance in different individuals that are comparable as to season and age.

This species, like most microtines, begins to breed at an early age, and greatly increases in size after birth of the first young. The largest specimens (5 males and 3 females) of the series, apparently all entitled to be classed as adult, measure as follows: Total length, 143.6 (134–150); tail vertebræ, 22.3 (20–25); hind foot, 19.9 (18.5–22); ear, 11.5 (10–13). Three additional females that appear to have suckled young range in total length from 124–129, with the other measurements proportional.

This species differs considerably in color from either *L. trimucronatus* or *L. alascensis*, and still more in cranial details.

Of this species Mr. Anderson says: "The short-tailed yellowish voles taken at Telegraph Creek inhabited a long, rather dry little valley near the top of the 'Summit.' At the time I attempted to trap them, a light snow fell during the first night, and in the morning we saw a number of places where these animals had burrowed through the snow and made long winding trails to the surface, not merely tracks, but trails, as if they had dragged their bodies through the soft snow. I followed one of these for more than twenty yards. It ended in a little tunnel in the snow." At Level Mountain he says: "The small number of the short-tailed yellowish voles which I took here was from holes beneath rocks imbedded in the moss and lichen in places back from the streams, but nevertheless often very damp."

The following schedule is of interest as showing the relative abundance of the different species of Muridæ at the five principal localities in the Telegraph Creek region where collections were made, as from Mr. Anderson's report it is evident that the collecting was indiscriminate at each of the localities. The time spent at each was of course unequal, but the ratio of abundance, as indicated by the specimens taken, is not thereby affected.

	Telegraph Creek.[1]	Cheonnee Mts.[2]	Shesley River.[3]	Level Mt.[4]	Raspberry Creek.[5]
Mus musculus	3	—	—	—	—
Peromyscus arcticus	272	4	3	3	10
" oreas	—	1	—	—	—
Neotoma saxamans	41	—	—	2	2
Evotomys dawsoni	5	11	—	42	9
Microtus vellerosus	38	1	1	6	5
" drummondi	1	3	4	30	—
Fiber spatulatus	—	—	1	seen	seen
Phenacomys constablei	8	1	1	1	—
Synaptomys andersoni	—	—	—	1	—
Lemmus helvolus	28	—	1	11	1

[1] July 11–18, July 27–Aug 17, Oct. 17–20.
[2] July 21–25.
[3] Aug. 23–Sept. 6.
[4] Sept. 10–21.
[5] Oct. 4–13.

26. **Zapus saltator** *Allen.* Stickine Jumping Mouse.

Zapus saltator Allen, Bull. Am. Mus. Nat. Hist., XII, 1899, 3. March 4, 1899. Telegraph Creek, B. C.

Five specimens, taken as follows: Telegraph Creek, July 26 and August 13 and 15; Shesley, September 5 (2 specimens). Two of the Telegraph Creek skins were later destroyed by mice, but the skulls and measurements remain.

The yellow in the July specimen is rather paler and the back less dark than in the September examples, the former being in breeding pelage and the latter in fall pelage. An adult male and an adult female measure respectively as follows: Total length, ♂, 240, ♀, 234; tail vertebræ, 145, 149; hind foot, 32.5, 33; ear, 16, 15.

27. **Erethizon epizanthus nigrescens,** subsp. nov. Dusky Porcupine.

Type, No. 20772, ♂ ad., Shesley River, August 23; M. P. Anderson.

General coloration above black, lighter on the nape, sides of lower back, and thighs, where the tips of the hairs are yellowish; beneath uniform sooty black. Whole front and sides of the head sooty black, with a few white-tipped hairs on the nose; over the top of the head and nape, the long hairs are broadly tipped with pale yellow; over the shoulders and greater part of the back they are nearly all wholly black, a very few showing a slight tipping of yellowish; over the hinder back, rump, and median area of the tail the long hairs are wanting, but the spines are still wholly concealed by the long black underfur; the thighs and sides of the tail have the long black hairs broadly tipped with yellowish white. The spines, which show very plainly through the pelage on the sides of the shoulders, flanks, and thighs, are white, pointed with plumbeous over the shoulders and with blackish elsewhere.

Measurements (type). — Total length, 740: tail vertebræ, 210; hind foot, 90; ear, 27. Skull: Total length, 105; basal length, 99; zygomatic breadth, 67; mastoid breadth, 42; nasals, ? (broken away); upper molar series, 26. An adult female skull measures: Total length, 104; basal length, 98; zygomatic breadth, 71; interorbital breadth, 29; mastoid breadth, 45; nasals, ? (imperfect); upper molar series, 28.

Represented by two skins with skulls and two additional skulls. The extra skulls are from Level Mountains, and the

two skins, respectively, from Telegraph Creek, August 31, and Shesley River. The Shesley River skin is much the younger of the two, and in better pelage; the general coloration is less dark, owing to the greater abundance of long hairs, which are more broadly tipped with pale yellowish white.

Compared with Dr. Merriam's description of *E. epizanthus myops* from the Alaska Peninsula, and with a very fine large November specimen from Kenai Peninsula, the present form differs strikingly in its very much darker coloration and the much paler tips of the long hairs, which are pale yellow instead of deep yellow. The skulls of porcupines differ so greatly with age and individually, and the material for comparison is at present so scanty, that no very positive cranial differences are apparent. The four skulls of the present series, however, agree in possessing a very marked depression of the top of the skull at the fronto-parietal region, and in the great development of the lateral border of the interorbital region, which, just behind the orbits, forms a high obtuse knob, thus greatly emphasizing the fronto-parietal depression. In an equal number of Alaska skulls referable to *myops* both these features are practically absent.

"Porcupines are not infrequent near Telegraph Creek, though we took but one specimen." The same report is made for the camps at the head of Shesley River and Table Mountain.

28. **Lepus saliens** *Osgood.* Lake Bennett Hare.

Lepus saliens Osgood, N. Am. Fauna, No. 19, Oct. 6, 1900, 39. "Caribou Crossing, between Lake Bennett and Lake Tagish, Northwest Territory, Canada."

Two adult specimens, male and female, Telegraph Creek, October 20 and 21. Both are in change from summer to winter pelage, the female retaining the summer coat except on the ears and feet, which have turned white. The male specimen is a little more advanced in change, the ventral surface, rump, and flanks having become white as well as the ears and feet.

Summer pelage. — Female, No. 20770. Dusky gray brown, copiously varied with black; the underfur is pale plumbeous tipped with wood brown; the longer hairs are plumbeous for their basal half, then broadly ringed with pale wood brown and tipped with black. Lower back blackish; head brighter than the back, the hairs ringed subapically with rusty brown instead of pale wood brown. Prepectoral band very broad, rusty buff.

The male is similar in coloration where the summer coat still remains, the back being gray brown varied with black, and the top of the head rusty brown.

Measurements. — The external dimensions as taken by the collector are as follows: Total length, ♂, 455; ♀, 475; tail vertebræ, 40, 40; hind foot, 135, 130; ear, 74, 75. Skull: Occipital-nasal length, ♂, 74, ♀, 77.5; greatest zygomatic breadth, 38, 37; length of nasals, 27.5, 30; greatest width of nasals, 15, 14; alveolar length of molars, 13, 14.3.

If these specimens are correctly referred to *L. saliens*, the total length of the type of the species, "measured from dry skin," is apparently much too small (395 mm. as against 455 and 475 in the present specimens), as the other measurements conform satisfactorily with the Telegraph Creek specimens.

Although hares "were said to be not uncommon at Telegraph Creek," the "two specimens brought in on October 20 and 21" were the only examples secured.

29. **Phoca richardii pribilofensis** *Allen*. Pribilof Harbor Seal.

Phoca richardii pribilofensis Allen, Bull. Am. Mus. Nat. Hist., XVI, 1902, 495. Dec. 12, 1902. Pribilof Islands, Alaska.

One skull, adult male, from the western end of the Alaska Peninsula. Total length of skull, 209; zygomatic breadth, 130.

30. **Canis occidentalis** (*Richardson*). Gray Wolf.

Canis lupus, occidentalis Richardson, Fauna Bor.-Amer., I, 1829, 60, 62. "Northern Wolf of America."

One specimen, old female, Little Tahltan River, August 17. Length, 2642; tail vertebræ, 406; hind foot, 254. Skull, total length, 200; zygomatic breadth, 127. General color

pale yellowish white, strongly varied with black over the whole dorsal area, where black is the prevailing color, including upper surface of tail; top and sides of head, from the eyes posteriorly, lighter, gray varied with black, the nose reddish brown, varied with black; ears externally ochraceous rufous, varied on the apical half with black, and whitish internally; fore limbs ochraceous buff, brightest externally; hind limbs similar but much paler.

31. **Vulpes alascensis abietorum** *Merriam.* FIR FOX.

Vulpes alascensis abietorum MERRIAM, Proc. Wash. Acad. Sci., II, 669. Dec. 28, 1900. Stuart Lake, B. C.

A young female, skin and skull, Level Mountain, September 12. This specimen is so young that it still retains the milk dentition. Consequently its relationship cannot be satisfactorily determined. It is referred here on geographical grounds.

32. **Ursus middendorffi** *Merriam.* KADIAK BEAR.

Ursus middendorffi MERRIAM, Proc. Biol. Soc. Wash., X, 69, April 13, 1896. Kadiak Island, Alaska.

Represented by 30 skulls from Kadiak Island, varying in age from young still retaining part of the milk dentition to very old males and females. Four of the largest old male skulls measure as follows: Total length (front of premaxillaries to end of occipital crest), 428 (408–440); basal length (gnathion to posterior border of occipital condyles), 402 (390–408); zygomatic breadth, 291 (282–303); interorbital breadth, 97.5 (94–100); width across postorbital processes, 138 (132–142). A large 'young adult' male (all the sutures still open): Total length, 405; basal length, 392; zygomatic breadth, 230; interorbital breadth, 86; postorbital processes, 116. Four other smaller but very old skulls, presumably females, measure: Total length, 366 (350–380); basal length, 336 (312–350); zygomatic breadth, 224 (220–227); interorbital breadth, 86 (83–91); postorbital processes, 122 (120–126).

33. **Ursus sitkensis** *Merriam.* Sitka Bear.

Ursus sitkensis Merriam, Proc. Biol. Soc. Wash., X, 73, April 13, 1896. Coast, near Sitka, Alaska.

A single skull, obtained at Sitka.

34. **Ursus horribilis** *Ord.* Grizzly Bear.

Ursus horribilis Ord, Guthrie's Geogr., 2d Am. ed., II, 1815, 291, 299. Montana (Merriam).

An old female and a male cub, skins and skulls, Shesley Mountains, September 2. The old female measures: Total length, 1626; tail vertebræ, 146; hind foot, 292. Skull: Total length, 332; basal length, 313; zygomatic breadth, 192; interorbital breadth, 75; postorbital processes, 105.

35. **Ursus americanus** *Pallas.* Black Bear.

Ursus americanus Pallas, Spic. Zoöl., fasc. xiv, 1780, 5.

An old male, skin and skull, Shesley Mountains, August 27. Total length, 1524; tail vertebræ, 152; hind foot, 229. Skull: Total length, 260; basal length, 252; zygomatic breadth, 170; interorbital breadth, 69; postorbital processes, 99.

36. **Putorius cicognanii richardsoni** (*Bonaparte*). Richardson Weasel.

Mustela richardsoni Boneparte, Charlesworth's Mag. Nat. Hist., II, Jan., 1838, 38. "North America" (Great Bear Lake, *apud* Bangs).

This animal is represented by 7 specimens, 5 males and 2 females, taken as follows: 6 specimens (4 males, 2 females), Telegraph Creek, August 11–15; 1 male, Level Mountain, September 17. They vary considerably in depth of color, some being much lighter than others, even when taken at the same place, on the same day. An examination of the skulls shows that in the case of both males and females, the palest specimens are very old adults and the darker ones young adults. One specimen (one of the oldest) differs from all the others in having no white on the hind feet and barely a trace of white on the fore feet.

The five males measure as follows: Total length, 330.5 (302–348); tail vertebræ, 99.5 (94–108); hind foot, 43.5 (41–46); ear, 20.5 (20–21.5). The two females measure respectively: Total length, 265, 250; tail vertebræ, 80, 70; hind foot, 34.5, 32; ear, 16, 16.

Four of the specimens are almost pure white below and the other three show a decided tinge of yellow.

37. **Putorius microtis,** sp. nov. SMALL-EARED WEASEL.

Type, No. 19964, ♂ ad., Shesley, September 24; M. P. Anderson.

Similar in coloration, including the white on the feet, to *Putorius c. richardsoni*, but very much smaller, with very small ears and very pronounced cranial characters.

Above dark brown, with a slight tinge of golden, but not very decidedly different from yellowish-brown specimens of *richardsoni;* below white, with a strong tinge of sulphur yellow; extent of white on the toes of both fore and hind feet about as in average specimens of *richardsoni*. Ears very small, 2 mm. less in height, and in general size one-half less than in *richardsoni*.

Skull. — Rostral and interorbital portions of the skull very broad, the nasals broader than in the much larger *richardsoni;* zygomata, weak, uniformly curved outwardly; postpalatal fossa small, narrow U-shaped; audital bullæ small, flat, very little inflated in comparison with *richardsoni*, the small development of the bullæ coördinated with the small external ear.

Measurements. — Total length, 295; tail vertebræ, 82; hind foot, 37; ear from crown, 19 mm. Skull: Total length, 40; zygomatic breadth, 20.5; length of nasals, 7; width of nasals at middle, 3.5; length of palate, 14; interorbital breadth, 9; postorbital breadth, 9.5; breadth across postorbital processes, 11; mastoid breadth, 14; breadth of skull across audital bullæ, 19; length of audital bullæ, 12; width of bullæ, 7; height of bullæ above postpalatal floor, 1.6; length of premolar-molar series, 9; length of lower jaw, 20; height at coronoid process, 9. The size of the skull is intermediate between that of male and female skulls of *richardsoni*, male skulls of *richardsoni* of exactly corresponding age having a length of 45 mm. as against 40 in the present species and 35 in the female of *richardsoni*.

Represented by a single adult male taken at Shesley, British Columbia, September 24.

While similar in coloration to *Putorius richardsoni*, it is

readily distinguished externally by the very small ears. Its very distinctive cranial features render further comparison with allied species unnecessary.

This weasel was trapped by Mr. Anderson "in the same bunch of balsam firs where the bushy-tailed rats were secured."

38. **Gulo luscus** (*Linn.*). Wolverine.

An adult female, from Oizenoy Bay, Alaska Peninsula, June 7. Total length, 965; tail vertebræ, 229; hind foot, 178. Skull, naso-occipital length, 148; basal length, 135; zygomatic breadth, 96; interorbital breadth, 39; breadth of post-orbital constriction, 34.

39. **Sorex personatus** *I. Geoffroy.* Masked Shrew.

This species is represented by 34 specimens, collected as follows: Telegraph Creek, 21 (13 skulls and skins, and 8 additional skulls with field measurements), August 2 to 15 and October 19; Little Tahltan River, 1, August 18; Level Mountain, 2, September 15; Raspberry Creek, 9, October 7; and Sheep Creek, 1, October 14.

The Telegraph Creek and Raspberry Creek series measure as follows: Telegraph Creek, 20 specimens: Total length, 99.6 (96–104); tail vertebræ, 40.4 (37–44); hind foot, 11.9 (11–13); ear, 7.6 (7–8). Raspberry Creek, 9 specimens: Total length, 100 (96–105); tail vertebræ, 40.8 (40–42); hind foot, 11.9 (11–12); ear, 7.5 (6–8).

I also refer to this species 2 specimens taken by Mr. A. J. Stone on previous trips, as follows: Liard River, 1 specimen, Nov. 27, 1897; Fort Norman, 1 specimen, Sept. 17, 1898. From its very dark color the first mentioned of these two examples was formerly referred (this Bulletin, XII, 1899, p. 9) provisionally to *Sorex sphagnicola* Coues, but both agree well with the present species, and are too small to meet the requirements of *S. sphagnicola*.

The specimens from the Telegraph Creek region do not differ appreciably from specimens from northern Maine and New Brunswick.

40. **Sorex personatus streatori** *Merriam.* STREATOR SHREW.

Sorex personatus streatori MERRIAM, N. Am. Fauna, No. 10, Dec. 31, 1895, 62. Yakutat, Alaska.

Represented by 7 specimens from Wrangel Island, June 27 to July 7, and 2 from Kupreanof Island, November 3, the latter being in the plumbeous autumn pelage. The Wrangel Island specimens agree within about a millimeter with the measurements given by Dr. Merriam (N. Am. Fauna, No. 10, 1895, p. 63) for a series of 7 specimens from the same locality, Mr. Anderson's measurements being as follows: Total length, 107 (104–114); tail vertebræ, 45 (44–47); hind foot, 13.1 (13–13.5); ear, 7.7 (7–8.5). The Kupreanof specimens are slightly smaller and apparently less mature.

41. **Sorex obscurus** *Merriam.* MOUNTAIN SHREW.

Sorex vagrans similis MERRIAM, N. Am. Fauna, No. 5, Aug., 1891, 31, pl. iv., fig. 3. Salmon River Mountains, Idaho.
Sorex obscurus MERRIAM, N. Am. Fauna, No. 10, Dec. 31, 1895, 72 = *S. v. similis*, the name *similis* being preoccupied.

Represented by 33 skins and skulls and 7 additional skulls (with field measurements) collected at the following localities: Telegraph Creek, 10 specimens, July 15 to August 15; Cheonnee Mountains, 4, July 22–25; Shesley River, 4, August 23–31; Little Tahltan River, 1, August 18; Level Mountain, 4, September 15; Raspberry Creek, 10, October 7–13.

The Raspberry Creek series is in the ash gray pelage of winter, and thus contrasts strongly in color with all the others, which are in the brown pelage of summer. This series also averages slightly smaller in all of the measurements than those from the other localities, as shown by the following:

Telegraph Creek, 10 specimens: Total length, 112.9 (110–115); tail vertebræ, 45.3 (43–48); hind foot, 13 (12.5–13.5); ear, 8 (7–8.5).

Shesley River, 6 specimens: Total length, 115.3 (111–121); tail vertebræ, 45.6 (43–48); hind foot, 13 (12.5–15); ear, 8.6 (7.5–9).

Raspberry Creek, 10 specimens: Total length, 109.7 (102–

115); tail vertebræ, 44.3 (42–49); hind foot, 12.6 (12–13); ear, 7.8 (7–9).

Mr. Anderson states that the shrews were usually taken "where there was a growth of moss and lichens in moist places," or "in moist green spots near water," or "in groves of firs and pines, when the moss-covered ground was always damp."

42. **Sorex longicauda** (*Merriam*). LONG-TAILED SHREW.

Sorex obscurus longicaudata MERRIAM, N. Am. Fauna, No. 10, Dec. 31, 1895, 74. Wrangel, Alaska.

Represented by 20 specimens (topotypes) from Fort Wrangel, taken June 25 to July 7, of which 2 are males and 18 females. The 2 adult males measure respectively: Total length, 132, 137; tail vertebræ, 56, 58; hind foot, 15, 16; ear, 8, 8. The 11 adult females measure: Total length, 129 (122–138); tail vertebræ, 56 (53–59); hind foot, 15.2 (14.5–16); ear, 8 (7.5–8.5). The series is very uniform in coloration, both above and below.

Four of the six November specimens of *Sorex* from Kupreanof Island (near Wrangel Island), taken November 3, 4, and 8, are also referred to this subspecies. They differ, however, in color from the Wrangel June-July series in being dusky plumbeous above, and in showing only a slight trace of a buffy wash on the gray of the ventral surface. Two of the specimens are moulting, apparently into the plumbeous coat from the brown dress of the breeding season.

This species differs from *S. obscurus* in its considerably larger size and more brownish coloration, particularly through the brownish wash of the ventral surface.

Mr. Anderson states that these specimens were "usually trapped under damp, overhanging mossy banks, or about the roots of up-turned stumps."

[**Sorex richardsoni** *Bachman*. SADDLE-BACKED SHREW.

Three specimens of this species, not previously recorded, were taken by Mr. A. J. Stone at Fort Norman, Mackenzie

River, September 15, 16, and 17, 1898. This greatly extends to the northward the previous known range of the species, which has not been previously recorded from north of Edmonton, Alberta.]

43. **Sorex (Neosorex) palustris alaskanus** (*Merriam*). ALASKA WATER SHREW.

Sorex navigator alaskanus MERRIAM, Proc. Wash. Acad. Sci., II, 1900, 18. March 14, 1900. Point Gustavus, Glacier Bay, Alaska.

Two specimens, skins and skulls (male and female), and an additional skull (female). Total length, ♂, 148, ♀, 154, ♀, 157; tail vertebræ, 68, 74, 74; hind foot, 19, 19, 20; ear, 7, 8, 6.5.

Mr. Anderson says: "I secured three specimens of a large dark gray shrew with silvery underparts, from the banks of Telegraph Creek, where there was a dense growth and the ground was always moist."

Vespertilionidæ. BATS.

"During July a few small bats were seen flying about the village of Telegraph, but none were secured." (Anderson, MS. notes.) Mr. Osgood (N. Am. Fauna, No. 19, 1900, p. 45) occasionally met with small bats between Caribou Crossing and Fort Selkirk, Alaska. The specimens obtained proved referable to *Myotis lucifugus* (Le Conte).

Article XXII. — A NEW GENUS OF GROUND SLOTH FROM THE PLEISTOCENE OF NEBRASKA.

By Barnum Brown.

Plates L and LI.

Paramylodon, gen. nov.

This genus is founded on a nearly perfect skull and lower jaw in the American Museum collections (No. 2780), with associated skeletal material including five cervical vertebræ, tibia, fibula, calcaneum, astragalus, lunar, middle digit of manus, and ribs, found by the Expedition of 1897 near Hay Spring, Nebraska. Professor Henry F. Osborn has placed this material in the writer's hands for description.

The following characters distinguish it from allied genera:

Skull elongate; muzzle inflated; dentition $\frac{4}{4}$; first upper molar the largest of the series; last lower molar trilobate; first lower molar without opposing tooth.

Paramylodon seems to have been less specialized than *Mylodon*, retaining features of the older, more primitive sloths. From the long nasals it seems improbable that it had a proboscis, while the greatly inflated muzzle, and the large movable premaxillæ, indicate a large prehensile lip. The reduction of the twelfth nerve [1] shows a less specialized tongue than in *Mylodon*. The rounded condyles, with the greater part of the articular area on the ventral surface, and the aspect of the foramen magnum, opening obliquely to the long axis of the skull instead of backward, show that the head was carried more at right angles to the vertebral column than in *Mylodon*. The long calcaneum with posterior end resting flat on the ground, and the astragalar facet looking forward, indicate a primitive foot more flexible at the ankle than in the contemporaneous *Mylodon*.

The sum of these characters points to a difference in feeding habits and indicates that *Paramylodon* was a grazer.

[1] As indicated by the small condylar foramen in the skull.

Synopsis of Allied Genera.

	Mylodon.[1]	*Grypotherium.*	*Paramylodon.*
Number of teeth in skull....	5	4	4
Number of teeth in lower jaw	4	4	4
Character of last molar of lower jaw..............	bilobed	bilobed	trilobed.
Character of first molar of lower jaw...............	elliptical, opposes m^2	cylindrical, opposes m^1	elliptical, long, not opposing any tooth.
Character of muzzle.........	slightly contracted, rugose.	contracted, with osseous interseptum.	inflated, thin and smooth.

Generic Chronology.

1840. *Glossotherium* Owen, Foss. Mam. Voy. Beagle, p. 57. No species named. Type, the back of a skull from S. America.

1840. *Mylodon* Owen, *ibid.*, p. 86. Type, *M. harlani*, based on a jaw found in Kentucky, which had been previously referred by Harlan to his *Megalonyx laqueatus*. Referred species, *M. darwini*, based on jaws, etc., from S. America.

1842. *Mylodon robustus* Owen. Skull and skeleton. *Glossotherium* here made a synonym of *Mylodon*.

1855. *Lestodon* Gervais. Type, *L. armatus*, which (*fide* Lydekker) is not generically distinct from *Mylodon*.

1879. *Grypotherium* Reinhardt. Founded on skulls of *Mylodon darwini*.

1880. *Pseudolestodon* Gervais and Ameghino. Type, *Mylodon gracilis* = *Lestodon myloides*.

1887. Lydekker, in his Catalogue of the Fossil Mammalia in the British Museum, correctly states that *M. harlani* is the type of the genus, and divides *Mylodon* into two groups: one represented by *M. darwini*, the other including *M. harlani*, along with *M. robustus*, *M. littsomi*, *M. armatus*, and *M. gracilis*. In the first, "the first tooth in each jaw is extremely minute and wears horizontally." His reason for placing *M. harlani* with the second group is, perhaps, that a jaw shorter in front than the length of the dentition is indicated in that species, as is the case in *M. robustus*, etc., while in *M. darwini* the predentary portion of the jaw is much elongated.

1899. *Neomylodon* Ameghino. Type, *N. listai*.

[1] *M. robustus.*

1900. ROTH and SMITH WOODWARD identify *Neomylodon* with *Grypotherium*, which they hold to be generically distinct from *M. robustus*, etc. (presumably from Lydekker's second group as a whole, and therefore by inference from the typical *Mylodon*).

1900. AMEGHINO objects to the use of *Grypotherium* on the ground that it was founded on the type species of *Mylodon*, which he erroneously supposes to be *M. darwini*.

The type of *M. harlani* should be in the Columbia University Museum, but has been lost or mislaid. A cast of it, in the Museum of Williams College, has been loaned to the writer through the kindness of Professor Cleland. Comparison of this cast with a series of skulls of the subsequently described genera and species shows that *M. harlani* is not congeneric with *G. darwini* and is nearest, on the whole, to *M. robustus* This classic species, therefore, is properly referred to *Mylodon* and the characters of the genus may be derived from it. *Grypotherium* appears to be a valid genus, but its name may, perhaps, be antedated by *Glossotherium*. *Lestodon* is a valid genus; *Pseudolestodon* is not separable from *Mylodon*.

Paramylodon nebrascensis, sp. nov.

SKULL.

Basal View. — The upper *dentition* comprises eight teeth set in two diverging rows at such an angle that the space separating the two anterior is twice that separating the two posterior teeth.

The *first molar* is the largest and simplest of the series, having the form of an elongated ellipse, with the longer diameter twice that of the shorter. It is greatly curved antero-posteriorly, the convex surface in front; the sides are straight. The longest diameter of the tooth is parallel to the dental series, and the outer side forms a line with the posterior teeth. The crown is worn deepest in the middle.

The *second molar* is bilobed; the anterior lobe stands at right angles and the posterior lobe oblique to the series. The tooth is triangular, with the angles rounded. The anterior side is gently convex; the inner side is marked by a deep

sulcus, a little in front of the middle; the outer face is marked by a corresponding sulcus opposite but not quite so deep. These sulci, on opposite sides, form the constriction that divides the tooth into two lobes. Its greatest length is oblique to the line of the series.

The *third molar* is bilobed but somewhat modified from the preceding. The anterior side is gently convex with a faint indication of a groove in the middle. The inner side is shortest with a deep sulcus near its middle, while the outer side is longest with a less defined sulcus. The outer anterior angle is convex, as in the preceding tooth, but much broader. The greatest diameter is oblique to the series.

The *fourth molar* is shaped like the figure 8; the anterior lobe is larger and slightly oblique to the dental series. The anterior side is convex; the outer and the inner sides are nearly parallel, and near the middle of each is a sulcus that forms the constriction dividing the tooth into two lobes; the posterior side is convex but not as wide as the anterior side. The greatest diameter is parallel to the series. The plane of the alveolar outlet slopes from without, inwards and downwards; the space separating the alveoli of the first two is about twice that separating the succeeding teeth.

The maxillary part of the *palate* is of a triangular form with the base turned forward; gently convex from the palatines forward to a line connecting the anterior borders of the first molars, from which point it bends downward to the end of the maxillaries. The surface is pitted with several rows of small deep foramina parallel to the alveoli, and the anterior palatine foramina are situated on either side of the median premaxillary notch, passing forward, in two shallow grooves on each side, to small notches on the inner anterior border. The median maxillary suture presents a raised ridge, on either side of which is a shallow groove extending from the antepenultimate molar back to the palatines. The anterior border of the *maxillaries* presents two rounded thickened surfaces, separated by a deep median notch, for the articulation of the *premaxillaries*, which must have been large and movable, indicating a large prehensile lip. Directly in front of the

first molar, marking the boundary of the premaxillary surface, is a small deep notch, back of which there is a small expanded area marking the widest part of the maxillaries.

The *palatine* is concave and smoother than the maxillary surface; the median sutural line is not prominent. Anteriorly the palatines join the maxillaries in an irregular suture, anterior to the alveoli of the last molars; laterally it unites with the maxillaries just internal to the alveoli. The posterior palatine foramina, situated on the outer side near the origin of the descending pterygoid processes, are the only openings in the palatines. Posteriorly they expand to unite with the orbitosphenoids and are separated by a wide entering notch.

The *pterygoids* will be described from the outer aspect. Internally they are convex, with a rugose posterior border forming the lateral boundaries of the large posterior narial opening.

The *sphenoidal bones* are not suturally defined from one another: that part forming the roof of the nasal depression between the pterygoids is broadly arched from side to side, and wider than in *Mylodon;* the surface is smooth with two longitudinal channels parallel to the base of the pterygoids. Posteriorly the narial opening is bounded by two rough subelliptical tuberosities.

The *basioccipital* is a broad concave plate, the posterior edge of which is deeply incised, forming the lower boundary of the foramen magnum; the palate is pierced by a small vascular foramen immediately in front of the condyles. The anterior condylar foramina are large, but not more than half the diameter of those in *M. robustus.* External to the condylar foramen the basioccipital continues in a strong rough tuberosity forming the posterior inner boundary of the articular depression for the stylohyal, and also the posterior boundary of the jugular foramen. The sides of the basisphenoid descend rapidly in front of the jugular foramen, ending in the large tuberosities before mentioned as bounding the posterior narial opening.

The *condyles* are rounder and shorter than in *Mylodon,*

without the encroaching ridge which bounds the articular surface in that genus. The convex surface of each condyle is inclined a little outwards; the inner edges bounding the foramen magnum converge from the upper to the lower boundary. The condyles stand away from the skull more than in *Mylodon*, and the greater articular area is on the lower surface. The foramen magnum looks downwards as well as backwards.

The *tympanic* is lost, leaving exposed the petrous bone wedged in between the sphenoid, exoccipital, and squamoso-temporal bones. The inner portion is a subcompressed, conical protuberance uniting with the basisphenoid in a straight line, forming the outer and posterior margin of the carotid canal. In *Mylodon* the basisphenoid is distinctly emarginated for its reception. On the outside and posterior to the conical process the petroso-temporal sends down a rugged process forming the anterior boundary of the jugular foramen and the depressions for the stylohyal. In front it bounds the posterior part of the tympanic cavity. The bony canal of the Eustachian tube expands where it communicates with the narial aperture, separating the pterygoids from the sphenoid protuberances.

Side View.— As in *Mylodon* the side view of the skull presents the form of an elongated parallelogram. The occipital plane inclines forward as it rises to the upper surface of the skull. The top of the cranium presents a nearly straight line slightly depressed at the posterior end of the nasals. The muzzle ends in a slightly curved line; nasals and maxillaries about the same length above, with protruding palate. Ventrally the basicranial outline is interrupted by the greatly expanded pterygoid.

The *supraoccipital* element forms nearly the whole of the posterior region of the skull, joining the parietals in a transverse lambdoidal suture, which forms the crest but does not encroach upon the coronal surface of the skull. From the condyles the broad *occipital plate* rises upward and forward, first at an angle of about 75° to two-thirds its height, and then forward to the lambdoidal suture at an angle of 60°. It is divided into two equal areas by a prominent occipital crest.

On each side of this crest there is a shorter parallel ridge extending from above to about the middle of the skull. Immediately above the left condyle there is a small foramen. A deep groove separates the condyle from the occipital plate.

Wedged in between the occipital and temporal regions is the prominent *mastoid*, about half as wide as it is long, bounded above by a continuation of the suture that separates the exoccipital from the supraoccipital. The outer margin is raised into a prominent ridge forming the lower posterior boundary of the temporal fossa. Immediately inside this ridge there is a deep channel running upward, ending in the mastoid foramen. The entire posterior surface of the mastoid, between the raised outer border and the exoccipitals, is a depressed rugose area. The inner part of the lower end of the mastoid is a cup-like depression for the articulation of the stylohyal, which is not nearly so deep or so extensive as in *Mylodon.*

The *temporal fossa* is uniformly smooth with an extensive depression just above the mastoid, and a large protuberance above this area, as in *Mylodon.*

The *zygomatic process* of the temporal is a stout trihedral bone, the upper edge of which is nearly straight; the external surface is nearly flat and gently convex. The under surface is broad and flat for the articulation of the lower jaw, without any distinct glenoid cavity, thus allowing a great forward and backward movement of the jaw. The anterior end of the zygoma terminates in an obtuse point.

The *malar* undoubtedly articulated loosely with the maxillary and the zygoma, but unfortunately is missing on both sides.

The most prominent bone of the skull is the *pterygoid*, which extends downward and outward in a broad plate ending in a very wide convex border, more prominent than in any allied genus. Posteriorly it descends from the sphenoid at an angle of twenty degrees, forming the gently rounded distal end, then sweeps upward, in a quarter arc of a circle. The external surface is rugose with a prominent ridge parallel to the zygoma dividing it into two depressions. In the posterior part of the upper one is the large foramen ovale, which opens

forward and upward in a small canal at the upper border of the pterygoid, partly defined by the overhanging projection of the temporal. The posterior upper border is marked by deep channels and ridges.

The *frontal* is the largest bone of the skull, forming the middle half of the upper surface of the cranium, articulating in front with the nasal, maxillary, and lachrymal, below with the lachrymal, maxillary, and orbitosphenoid, and behind with the parietal and squamosal. Externally it presents a smooth surface of irregular curves expanded in front at the postorbital process, extending downward and inward to unite with the maxillary below the lachrymal, with a deep overhanging fold exterior to the optic foramen, as in *Glyptodon*. Above the optic foramen it descends outward slightly to unite with the orbitosphenoid.

The *orbitosphenoid* is not suturally defined but represents a depressed area, bounded on the outside by an overhanging wall of the frontal containing the optic foramen and foramen rotundum separated by a thin wall of bone.

The *lachrymal* presents an irregular outline, the superior border of which rises anteriorly above the malar in a rugose surface, in the centre of which is the lachrymal foramen. The posterior portion is much thinner and extends back in a truncated point to a line connecting the postorbital process of the frontal and the posterior margin of the last molar. Below the lachrymal foramen there is a deep rounded pit, with a raised cone in the center, for articulation with the malar.

That part of the *maxillary* presented in side view is of a quadrate form, convex on the outer surface, and extends nearly to the anterior end of the nasals, with which it forms a vertical cross-section. Posteriorly it unites with the orbitosphenoid at the beginning of the canal that leads into the optic foramen; above, with the lachrymal, frontal, and nasals. The malar process is a stout projection set obliquely to the maxillary, forming the anterior buttress of the malar and enclosing the infraorbital foramen. Across the middle of the maxillary, beginning above the infraorbital foramen in a

curved line from the lachrymal foramen to the middle of the muzzle, there is a line of foramina of decreasing size.

Top View. — The length of the skull from the condyles to the upper anterior border of the maxillary is about the same as in the type of *M. robustus.* In the mastoid region it is slightly narrower, while across the anterior end of the zygoma at its widest point, behind the postorbital process and at the muzzle, it is much narrower. The upper surface is uniformly smooth; gently convex transversely; nearly flat in the parietal region, and slightly depressed from the postorbital process forward, but much less than in *Mylodon.* The face is much narrower than in *M. robustus* and the nasals are more highly arched; in the type, the nasals are crushed down into the narial opening. At the anterior end the nasals are slightly deflected, terminating in an outer rounded edge, the median halves presenting wide notches with two central, extended points and articular upper faces, to which were probably attached an incipient osseous interseptum. No well defined ridge separates the top of the skull from the temporal fossa, this surface merging into the sloping sides of the skull without any marked separation. The posterior boundary is formed by the thickened deltoid ridge, behind which are seen the sloping occipital region and the condyles.

Lower Jaw.

Dentition. — The *first molar* is smallest in diameter and simplest of the series: it is ellipsoid in cross-section and tapers to a point, the internal and posterior borders of which are worn down, leaving a crescentic anterior border. This tooth projects far above the crowns of the succeeding teeth (canine-like) and has no opposing tooth in the upper jaw.

The *second molar* presents an irregular trapezoidal outline with rounded angles, the posterior one most produced. The external side is convex, while the internal side is strongly concave, the concavity marked by a deep sulcus in the middle. The anterior and the posterior sides are concave, the latter more strongly pronounced. The sulci of the internal and the

posterior sides tend to divide the tooth into two lobes. The posterior lobe is worn obliquely. The greatest length is oblique to the dental series.

The crown of the *third molar* is broken off, but the root gives the shape and dimensions of this tooth accurately. The external side is slightly convex, nearly straight. The internal side is slightly concave with indication of a groove in the middle. The anterior and the posterior sides are concave, with a faint groove in the middle of each. The greatest length is oblique to the dental series.

The *fourth molar* is the largest and most complicated of the series. It is composed of three lobes: a large anterior lobe, oblique to the dental series; a posterior lobe, more than half the size of the anterior lobe, transverse to the series, and a much smaller, less defined middle lobe, connecting the two and parallel to the series. The anterior lobe is convex on the internal and the external sides, concave on the anterior side, with a faint double groove in the middle, and concave on the posterior border, drawn out to form the connecting middle lobe, which unites with it on the internal half of the posterior border. The external and the internal sides of the posterior lobe are convex, and the posterior side is convex, with a slight median groove; the anterior side is convex, uniting with the middle lobe on the outer half. The middle lobe is well defined on the outer face by two deep sulci, and less marked on the internal side by two broad shallower sulci. The anterior and posterior borders are drawn out to form the connecting isthmuses, the latter being twice the width of the former. The posterior and half of the middle lobes of this tooth opposed the last molar of the upper series, and the crown is nearly flat. The anterior lobe opposed the second molar of the upper series, and the crown is worn in a crescentic surface.

Ramus, etc. — The *ramus* of the lower jaw is long and robust but contracts rapidly to the symphysial region. It is thick and massive in the dental portion and expanded in a thin vertical plate posteriorly. The external surface is concave — rounded both vertically and horizontally. The internal sur-

face may be divided into three regions: the anterior, which, from the second molar to the symphysis, is convex vertically and concave horizontally; the middle, from the second to the last molars, which is nearly flat; and the posterior, back of the last molar, which is deeply concave. The lower border is rounded and thickened below the dental series, thinning out anteriorly and posteriorly. The upper or alveolar border is wide and rugose, and on the outside of the jaw there is a shallow depression extending the entire length below the alveoli.

The anterior expanded end presents an obliquely sloping *symphysis*, nearly half as wide as deep, extending anteriorly in a deep rounded border. From a front view this anterior border has the outline of a keel-like projection extending forward in the middle of the jaw. Below this keel is a rounded mammilloid process, much less prominent than in *Mylodon*. The portion of the jaw in front of the first molar is longer than in *M. robustus* and the width of the expanded portion is much less. The dental region is not nearly so deep as in *Mylodon*.

The posterior part of the jaw is expanded into a thin deep plate, divided into the *coronoid*, *condyloid*, *and angular processes*. The point of the *angular process* is broken off; the lower margin is convex and the inner side presents a deep concavity bounded below anteriorly by the inferior inflected border of the process and a ridge that extends forward and upward to near the alveolus of the last molar; below, posteriorly, the inner border is roughened by processes; above, it is bounded by the rounded border of the dental canal. The outer surface of the angle is convex and rugose.

The *coronoid* process is broken at the point but seems to have been nearly straight, slightly convex on the anterior border.

The *condyle* is long and narrow, set obliquely to the vertical plane of the coronoid. The greater part of the condyle overhangs the supporting plate of bone, only about one fourth extending on the outer side of the ramus. It rises from a triangular base, the outer angle of which begins below the

notch separating the coronoid from the condyle, and passes backward and upward in a sharp ridge, forming the outer articular border of the condyle. The articular surface is slightly rounded.

The *dental canal* begins in a deep elliptical depression at a point below the origin of the condyle and passes forward to the entry of the large dental foramen. It continues forward in two divisions: the smaller and shorter, opening on the outer side of the jaw, opposite the posterior border of the last molar; the larger, passing forward and dividing into three branch canals that open on the outer side of the jaw where it bends forward to form the symphysis. These foramina are about 10 mm. apart, and the middle one is the largest. The smaller ones are about one fourth the diameter of the larger one. Near the depression that gives rise to the dental canal is a narrow deep channel that passes downward and forward under the upper part of the ridge bounding the concavity of the angle where it divides and comes to the surface in two foramina 20 mm. apart.

Tibia.

The tibia is a short, massive bone with a flattened shaft. The proximal end is greatly expanded laterally and in width is about three fourths of the entire length of the tibia. In general appearance and proportions it agrees with the type of *M. robustus* with the following exceptions. The external condylar facet is distinctly pyriform. In *M. robustus* it is circular. The fibular facet is elliptical and slightly concave; oblique to the condylar surface and sloping from without inward and downward. Anteriorly it nearly meets the superior surface. Posteriorly they are separated by a convex facet for the articulation of a sesamoid. The distal articular surface is divided as in *M. robustus*, but the external semi-elliptical compartment is convex, while in *M. robustus* it is flat. The external malleolus is not as prominent as in *M. robustus*.

Fibula.

The fibula is a subprismatic bone enlarged at both ends. The outer surface of the shaft is convex; the inner surface

flattened, slightly convex and rugose, the posterior border thin and rounded. The upper end of the inner surface is excavated with a rugose border. The proximal end is truncated obliquely, presenting two facets: the outer and smaller for the articulation of a sesamoid; the inner (a very long surface convex in its narrowest dimension) for articulation with the tibia. About one half of the proximal end of the fibula on the outer side presents a rugose border and excavated surface for the attachment of the peroneus longus. The tibial facet is prolonged backward in a hook-like process. The distal end is expanded in an irregular quadrilateral form on the inner surface and a convex, very rugose, pitted obtuse point. The inner surface presents a deeply excavated concavity and two articular facets; the lower part of the concavity is occupied by the flat, oblique, tibial facet, which continues uninterruptedly into the vertical plane of the astragalar facet. The posterior distal third of the malleolus is rugose. In *M. robustus* the tibial and astragalar facets are separated by a transverse concavity.

Astragalus.

The astragalus, aside from being much larger than that of *M. robustus*, agrees with it in form and proportion with the following exceptions: The navicular facet is deeply excavated in the middle, with convex edges continuing uninterruptedly into the cuboidal facet. In *M. robustus* it is flat on its upper half and convex on the lower. The calcaneal facet is elongate and triangular to a greater extent than in *M. robustus*, with scarcely a perceptible constriction in the middle.

Calcaneum.

The base of the calcaneum forms a nearly straight plane, concave on its posterior triangular surface, and of greater length proportionally than in *M. robustus*, with a broadly expanded posterior end. The astragalar facet occupies a more anterior position than in *M. robustus*, while the large tendinous grooves on the outer side of the bone are similar, but the tuberosities marking their boundaries are more prominent. In other respects it agrees with *M. robustus*.

Lunar.

The transverse surface of the radial facet is convex in this form and the posterior extension of the same surface is broadly expanded, while in *M. robustus* it is nearly flat transversely and contracted on the posterior surface.

Digits of Manus.

The three phalanges of the middle digit are preserved, and differ considerably from those of *M. robustus*. The claw process of the *ungual phalanx* is somewhat deeper than wide, of an ellipsoid outline. The under surface is not separated from the sides by sharp ridges toward the distal end, as in *Mylodon*, and it is only toward the base that these ridges are shown. The *middle phalanx* resembles that of *Mylodon*, though the proximal facet is much deeper. The *proximal phalanx* is very much shorter than in *M. robustus;* the outer surface is twice the width of the inner surface and is expanded on the lower outer side. The proximal articular facet presents a deep concave channel for the articulation of the trochlea of the metacarpal; on the inner side of this channel, continuous with its inner edge, is a narrow, concave articular surface. The outer surface of the trochlear depression presents a sharp ridge. On the ventral surface there is a sesamoid facet on each side of the trochlear depression, the outer being the larger. The distal articular facet is a wide shallow channel, concave from side to side and convex vertically. Below the distal articular surface there is a rugose depression one fourth the height of the articular surface.

Measurements.

Skull.

	mm.
Length of m^1	29
Width " "	15
Length " m^2	26
Width " "	23
Length " m^3	23
Width " "	25
Length " m^4	30
Width " "	17

	mm.
Length of dental series	133
" " skull from condyles to end of maxillary	470
Depth of occiput in vertical line to condyles	136
Width across muzzle at widest part	128
Width at narrowest part back of postorbital process	89
Width of condyles	128

Mandible.

Length of m^1	20
Width " "	14
Length " m^2	24
Width " "	22
Length " m^3	31
Width " "	17
Length " m^4	56.4
Width " "	24.4
Length of dental series, alveolar measurement	180
Length of jaw from condyle to extreme point	371.3
Length of symphysis	120
Width of anterior end	445

Tibia.

Length	275
Proximal end across widest part	178
Distal " " " "	150

Fibula.

Length	280
Width of proximal end	105
Width of distal end	70

Astragalus.

Greatest breadth	150
" height	127

Calcaneum

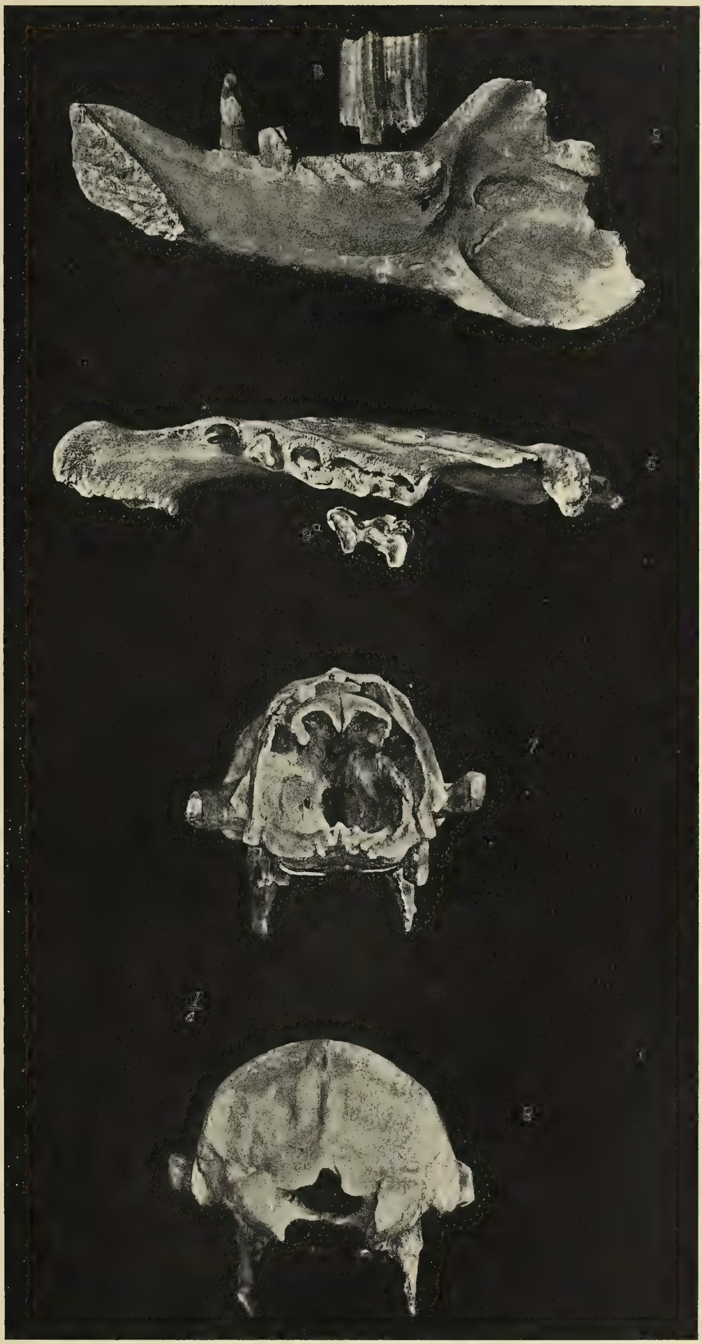
Length	240
Width across base	130
Height at posterior articulation of astragalus	123

Third Digit of Manus.

Ungual phalanx, length	180
Second " "	63
" " width	47
Proximal " length	33
" " width across middle	46

PARAMYLODON NEBRASCENSIS.

Type skull. $\times \frac{1}{4}$.



PARAMYLODON NEBRASCENSIS.

Type skull and mandible. The last lower molar (9, 9*a*) belongs to another individual. × ¼.

Article XXIII. — DESCRIPTION OF A NEW MOTH FROM NORTH CAROLINA.

By Wm. Beutenmüller

In beating the branches of the balsam fir and the black spruce on the summit of the Black Mountains in Western North Carolina, for beetles, on an expedition made by me through the kindness of Mr. Samuel V. Hoffman, several *Orgyia*-like larvæ dropped into my umbrella. At first sight I suspected I had before me the larva of an apparently new *Orgyia*, but which eventually proved to be the *Olene* here described. It is somewhat allied to *O. plagiata*, but the transverse lines and markings are different, nor is it anything like the other known species of the genus. I venture, therefore, to describe it as a new species.

Olene montana, sp. nov.

Male: Fore wings deep smoky brown with a slight violaceous lustre. Transverse lines and discal spot almost obscured by the ground color. A lighter brown shade at the middle, from the base to the transverse anterior line. Discal mark elongate, upright, curved inwardly, black, outlined, and with a few white scales. Transverse anterior line vertical, black, with three outward curves. Transverse posterior line, strongly curved outwardly around the discal mark, bending inwardly at about the middle, thence almost straight to the inner margin. A little above the inner angle is a distinct white spot. Line at base of fringes black, with two short teeth inwardly above the angle. Hind wings uniform smoky brown. Fringes concolorous. Forewings beneath almost uniform smoky brown, paler along inner margin, and with a faint indication of a dark transverse shade. Hind wings beneath smoky brown with a darker discal mark and median shade. Head and thorax smoky brown, the latter slightly lighter brown anteriorly. Abdomen paler than the thorax with two bunches of metallic brown hairs on the anterior segments, and a similar bunch on the disc of the thorax. Antennæ smoky brown. Expanse, 32 mm.

Female: Fore wings deep sepia brown, basal region at costa and inner margin somewhat smoky brown. Middle part sepia brown with a smoky brown shade. Outer part dark brown. Transverse lines distinct, black, similar to those of the male. Discal mark filled with clear white, and marked with this color on the outer and inner parts.

Marginal line black, marked with a little white inwardly, especially near the anal angle. Apex slightly tipped with lighter brown, with an indistinct double-toothed shade beneath it. White spot near anal angle a little larger than in the male. Hind wings uniform smoky brown. Underside wholly smoky brown, with slight indications of a darker median shade on each wing. Head, thorax, and abdomen same as the male. Expanse, 36 mm.

Larva: Head jet black, shining. Body black; brown on the back of the 8th to 12th segments with a short, cylindrical, cherry red protuberance on the 9th and 10th segments. Hairs on the sides of the body brown and black, with a black, plumose hair on each tuft. Bunches of hairs on the 4th to 7th segments inclusive, deep black, with short white, plumose hairs on each bunch at the sides. Hairs on the warts short, white or yellow, plumose. Warts on the 1st to 3rd segments inclusive, brown; on each side brown. On each side of the 1st segment is a long black pencil directed forward and a similar one on the 11th segment directed backward. Underside and legs brown. Length, 40 mm.

Food-plants. — Balsam fir (*Abies frazeri*) and black spruce (*Abies mariana*).

Cocoon: Oblong, oval; composed of silk mixed with the hairs of the larva. Length, 18–20 mm.; width, 8–9 mm.

Habitat. — Summit of the Black Mountains, North Carolina, altitude about 6000 to 6715 feet.

Five immature larvæ of this interesting species were collected on June 7. Two of these matured and spun cocoons on June 29, and pupated June 30. On July 8 a female and on July 11 a male emerged. Two larvæ were preserved in alcohol, and the remaining one escaped.

Article XXIV. — LIST OF MAMMALS COLLECTED BY MR. J. H. BATTY IN NEW MEXICO AND DURANGO, WITH DESCRIPTIONS OF NEW SPECIES AND SUBSPECIES.

By J. A. Allen.

The present collection was made for the Museum by Mr. J. H. Batty, mostly during the present year. During December, 1902, he collected in Donna Ana County, New Mexico, near the southern border, at localities less than one hundred miles west of El Paso, Texas. Early in January he went to the northwestern corner of the State of Durango, Mexico, where he continued his work till August, 1903, exploring the arid foot-hills and plains at the eastern base of the Sierra Madre, from the southern boundary of Chihuahua southward. The localities visited are embraced within an area of about one hundred square miles, and range in altitude from 6800 to 8500 feet. The region was practically unworked, and is somewhat distant from any point where thorough collecting had previously been done. The mammalian fauna is scanty, but proves unexpectedly rich in new forms, and in respect to coloration and some other features the species present, in general, distinctive peculiarities.

In general facies the fauna of this region more closely resembles that of the southern border of Arizona than it does that of the upper Rio Grande region of Texas and New Mexico. The thoroughness with which Mr. Batty worked is attested by a collection of about 600 specimens, numbering 34 species, many of which are represented in large series. The record of specimens given under each species doubtless fairly indicates their relative abundance.

The specimens collected in New Mexico proved of great interest for comparison with those from Durango, and in every case the forms inhabiting the two regions proved readily distinguishable. It was expected that the Durango forms would in most instances prove identical with species and subspecies

inhabiting the southern border of Arizona, but careful comparison, with the aid of abundant material, shows that such reference would in most cases fail to express their true relationships.

I am indebted to the kindness of Dr. A. K. Fisher, Acting Chief of the U. S. Biological Survey, and to Mr. Gerrit S. Miller, Jr., Assistant Curator of Mammals, U. S. National Museum, for the loan of topotypes of various species for use in the present connection.

[NOTE. — The measurements taken by the collector from the fresh specimens are as follows: (1) Head and body; (2) tail vertebræ; (3) hind foot, measured to end of longest toe (after the British Museum method), and hence not including the claw; (4) ear, measured from the notch instead of from the crown, except in a few cases, as in the hares, where both are often given. For convenience in comparison the total length is here also given, made up by adding the collector's first two measurements.]

I. Donna Ana County, New Mexico.

The specimens here recorded, about 150 in number, were all taken during the month of December (Dec. 6–26), along the southern border of Donna Ana County, a little west of El Paso.

1. **Citellus (Otospermophilus) grammurus** (*Say*).

One specimen, collected at Chamberino. "Not common."

2. **Peromyscus tornillo** *Mearns*.

Ten specimens: Guadalupe Ranch, 1, Dec. 3; La Mesa, 8, Dec. 13–17; Chamberino, 1, Dec. 26.

Seven adults (4 males and 3 females) measure as follows: Total length, 169 (163–171); head and body, 93 (90–95); tail vertebræ, 75.5 (73–76); hind foot (without claws), 20.6 (19–22); ear, 18.1 (18–18.3).

3. **Sigmodon hispidus berlandieri** (*Baird*).

Nine specimens, collected as follows: Guadalupe Ranch, 4, Dec. 13–16; La Mesa, 1, Dec. 19; Chamberino, 4, Dec. 26.

Only two are fully adult, both males, and measure, respectively: Total length, 248, 229; tail vertebræ, 102, 89; hind foot (without claws), 19, 19.

4. **Neotoma mexicana** *Baird.*

Forty-eight specimens, taken as follows; Guadalupe Ranch, 18, Dec. 8–13; La Mesa, 28, Dec. 13–18; Chamberino, 2, Dec. 25 and 26. Nearly one half are fully adult, one is in the plumbeous pelage of the young, and the rest range from half or two thirds grown to nearly adult.

Nine adult males from the La Mesa series measure: Total length, 324 (311–337); head and body, 180 (171–191); tail vertebræ, 145 (137–152, with 1 at 121 and 1 at 165); hind foot (without claws), 32.5 (32–36); ear (from notch), 27 (25–29). Five adult males from Guadalupe Ranch: Total length, 329 (305–347); head and body, 185.3 (172–197); tail vertebræ, 133 (127–140); hind foot, 32.8 (31.5–34); ear, 27 (25.5–29). Three females from La Mesa: 312 (305–319); 172 (165–179); 140 (140–140); 32 (32–32); 27 (25.5–28.5). Four females from Guadalupe Ranch: 298 (286–311); 170 (159–184); 128 (127–130); 32 (32–32); 26.3 (25.5–29).

5. **Lepus (Macrotolagus) texianus griseus** *Mearns.*

Represented by 17 specimens (7 males and 10 females), collected as follows: Guadalupe Ranch, 11, Dec. 6–12; La Mesa, 4, Dec. 16–20; Chamberino, 2, Dec. 27.

Ten females measure as follows: Total length, 560 (546–615); head and body, 469.5 (438–527); tail vertebræ, 82 (70–94); hind foot (without claws), 127.6 (114–145); ear from notch, 130 (124–140); ear from crown, 160 (156–162). Six males: Total length, 564 (432–626); head and body, 453 (432–528); tail vertebræ, 83 (70–98); hind foot (without claws), 131 (114–140); ear (from notch), 131 (121–138).

The specimens, all adult and in full winter pelage, vary but little in coloration; in a small percentage the back is much more strongly varied with black than the others; the gray of the upper parts is decidedly more tinged with brownish ful-

vous in some than in others, and, correlated with this, the sides are more strongly tinged with fulvous.

Lepus texianus griseus is very closely related to *L. t. eremicus* Allen, from the southern border of Arizona; it is a little grayer (the dorsal area less suffused with brownish), but in size and proportions there is apparently little, if any, difference.[1]

6. **Lepus (Sylvilagus) arizonæ minor** *Mearns.*

Represented by 37 specimens, all adult, collected as follows: Guadalupe Ranch, 22, Dec. 6–12; La Mesa, 7, Dec. 17–20; Chamberino, 8, Dec. 25–27.

Twelve males measure: Total length, 343 (310–361); head and body, 323.5 (292–327); tail vertebræ, 40 (35–44); hind foot, 77 (70–82); ear from notch, 65.4 (63.5–70). Ten females: Total length, 347 (307–378); head and body, 324 (306–330); tail vertebræ, 41 (35–44); hind foot, 76 (70–83); ear from notch, 66 (60.5–70).

7. **Lynx ruffus texensis** (*Allen*).

One specimen, adult female, Guadalupe Ranch, Dec. 6. Total length, 863; head and body, 711; tail vertebræ, 152; hind foot, 140.

II. Northwestern Durango.

The principal localities (mostly not on ordinary maps), with the dates during which collections were made, are as follows: (1) Rosario, altitude 7500 feet, on the Rio Florida, at the terminus of the Parral branch of the Mexican Central Railroad; Jan. 21–28. (2) Mount San Gabriel, altitude 7000 to 9000 feet; Jan. 28. (3) Rio del Bocas, a dry river bottom on the Rio Florida, altitude 6800 feet; Feb. 8–13. (4) Villa Ocampo, or Ville de Campo, a few miles below Rio de Bocas, on the Rio Florida, altitude 7000 feet; Feb. 11–13. (5) La Boquilla, a pass in the San José Mountains, at 7000 feet; Feb.

[1] I take this opportunity to correct an error in the original description of *L. t. eremicus* (this Bulletin, VI, 1894, p. 348, last paragraph of the description), where, through some inadvertence not now explicable, the measurements are quite wrong. The measurements given for the type (*l. c.*, p. 347) are correct, and the correct measurements of the series of 8 specimens will be found in Vol. VII, p. 202, *op. cit.*

14–16. (6) San Gabriel, a small adobe village, seventy miles northwest of Inde, in the plains, altitude 7000 feet; Feb. 17–20. (7) Rancho Santuario, an old "Spanish Grant" ranch, on the plains, altitude 7000 feet; Feb. 17–March 11. (8) Matalotes, at the head of the Arroyo Matalotes, at the base of the Sierra Madre, altitude 8000 feet; March 20–24. (9) Cienega de las Vacas, at base of Sierra Madre, altitude 8500 feet; April 6. (10) Rio Sestin, altitude 7500 feet—one of the most fertile valleys of the region; April 9–May 4. (11) Rancho Bailon, altitude 7800, in the foot-hills of a small range of mountains overlooking the Sestin Valley from the east, May 5–14. (12) Arroyo de Bucy, altitude 7500 feet, a deep rocky cañon in the Sierra del Candella; May 22–30. Very few of the specimens collected after June 1 have as yet come to hand.

1. **Odocoileus**[1] **battyi,** sp. nov.

Type, No. 21277, ♂ ad., Rancho Santuario, northwestern Durango, March 10; J. H. Batty, for whom the species is named.

Similar in size and coloration to *O. couesi*, but with strongly marked cranial differences.

General color (winter coat, type specimen) of upper parts gray brown, darker on top of head and along median line to base of tail, lighter on flanks; below, middle of throat white, passing into pale grayish brown on sides of throat and cheeks and posteriorly over fore neck and chest, which is darker, most of the hairs being tipped with blackish brown; lower breast, axillæ, and inside of fore legs white to hoofs, which are encircled with a band of white; middle of ventral surface grayer and slightly suffused with pale buff, passing into clear white on lower part of abdomen, inguinal region, inside of thighs, and inside of hind leg to tarsal gland, which is white with a central disc of deep orange chestnut; a narrow band of whitish encircling the hoofs, broadest and clearer white on the posterior aspect; ears thinly haired, gray brown externally, rather darker than the back, but not edged nor tipped with blackish, and clothed thinly internally with long white hairs; sides of nose with a patch of black, often connected across the middle and forming a distinct nose band; also a blackish spot, often faintly marked, on each side of the lower lip, near the middle, the two

[1] I am informed by Dr. T. S. Palmer that the generic name *Dama* Zimmermann (1777), recently adopted by me for the present group (this Bulletin, XVI, 1902, p. 19), is preoccupied through its previous use by Frisch (1775) for the *Cervus dama* of Europe.

sometimes uniting to form an indistinct band; tail basally above colored like rump, the upper surface with the hairs dark brown basally and tipped with white, the dusky basal portion showing through and giving the whole upper surface of the tail a grizzled white and brown effect; edges and lower surface clear white; posterior border of rump with a heavy fringe or ruff of white.

The above is about the average coloration of the series, but quite a number of the specimens have the gray brown of the upper parts paler, with a faint buffy tinge, decidedly apparent on the throat, lower edge of flanks, and whole pectoral region. In such specimens the upper surface of the tail is deep ochraceous, almost to the base of the hairs, the basal third of the hairs being yellowish brown. The fringe bordering the rump is mixed yellow and white, and the light inner surface of the limbs is also more or less suffused with buffy. Between these extremes there is every stage of gradation, which is especially striking in respect to the upper surface of the tail. In only a small portion of the specimens is the upper surface of the tail either dusky gray or yellowish, varying from the former through a faint tinge or mixture of yellow hairs to wholly yellow, deepening in some to orange ochraceous; nearly two thirds of the specimens have the dorsal aspect of the tail more or less conspicuously yellow.

Measurements. — An adult male,[1] total length, 1574; head and body, 1371; tail vertebræ, 216; ear, from crown, 190, from notch, 160. Five males, mostly middle-aged: Total length, 1460 (1237–1574); head and body, 1253 (1031–1371); tail vertebræ, 221 (215–229); ear from crown, 189 (178–198); ear from notch, 161 (152–168). Seven adult females: Total length, 1294 (1210–1371); head and body, 1081 (1007–1168); tail vertebræ, 208 (203–228); ear from crown, 176 (165–185); ear from notch, 157 (146–165).

Skull. — The skull is relatively much shorter and broader than in *O. virginianus*, with very much shorter and broader nasals, and very much smaller antorbital vacuities, but with the lachrymal pit shallow and imperforate,— not deep and perforate as in *O. couesi*. Compared with *O. couesi*, the antorbital vacuities are nearly one half smaller; the nasals are very much broader and less arched, with their greatest expansion generally at their posterior third instead of at the middle as in *O. couesi;* the walls of the posterior nares are more extended posteriorly and the narial opening is more vertical; the basisphenoid is more cuneate, through its greater expansion posteriorly; the dentition is very much heavier; the antlers bend more sharply outward and the outward curvature is nearer the skull.

The type skull, of a fine middle-aged, four-pronged buck, measures

[1] The measurements of the type are not recorded in the collector's field catalogue. Also the measurements of the hind foot are not available, having been taken from the metatarsal instead of the tarsal joint.

as follows: Total length, 248; occipito-nasal length, 201; basal length of Hensel, 220; zygomatic breadth, 115; least interorbital breadth, 61.5; mastoid breadth, 85.5; greatest length of nasals, 77; greatest width of nasals, 31; length of upper premolar-molar series, 69.5; length of lower jaw (from angle to outer base of middle incisors), 192; height at condyle, 64; height at coronoid, 96; alveolar length of lower premolar-molar series, 72. The antlers have a moderate bur, are nearly smooth, even proximally; beam round and rather heavy, with the usual basal tine and two points, one a little behind the middle, the other at the beginning of the posterior fourth, which with the tip of the main beam make four points, all rather short and heavy. Length of main beam along external curvature, 353; distance from bur to top of fork of first point in straight line, 71, to second do., 179, from second to third do., 103; length of main beam beyond last point, 98; distance between burs, 56, distance between tips, 218; greatest expanse, inside measurement, 340. Four other males, somewhat younger, have horns of similar character, but of much lighter weight and less developed points.

An adult female skull: Total length, 230; basilar length of Hensel, 203; occipito-nasal length, 190; length of nasals, 72; greatest width of nasals, 21; zygomatic breadth, 96; least interorbital breadth, 56; mastoid breadth, 66.5; length of upper premolar-molar series, 65; length of lower jaw, 176; height at condyle, 57; height at coronoid 86.3; lower premolar-molar series, 71.

Represented by 19 specimens (6 adult and 3 young males, and 9 adult females and 1 young female), collected as follows: Rosario, 2, Jan. 27 and 28; Mt. San Gabriel, 1, Jan. 28; Rancho Santuario, 5, March 10–11; La Cienega de las Vacas, 11, March 26–April 6. There is also an additional skull, "picked up on the plains," which in shape of antlers, the very broad antorbital vacuities, and the perforated lachrymal pit, agrees with *O. couesi* and not with the rest of the series.

Odocoileus battyi closely resembles externally *O. couesi* but differs greatly in cranial details, as above described. All of the deer of the arid regions of Arizona, Sonora, Chihuahua, and Durango, of the *O. virginianus* style of antlers, appear to present great similarity of coloration, but are found to differ in general size, in the size and shape of the antlers, and more or less in cranial characters, when specimens from distant localities are compared. As stated by me long since (this Bulletin, VII, 1895, p. 200), *O. couesi*, as first said by Coues and Yarrow, is the *Cariacus mexicanus* of Baird (excluding his synonyms), but is not the *Cervus mexicanus* of Gmelin and

later compilers. If we admit that Lichtenstein, in adopting the "*Cervus mexicanus* Desm." ("*Cervus mexicanus* Linn. Gm." on his plate) for the deer he described from Mexico, placed the name upon a recognizable basis, as contended by Lydekker (Deer of All Lands, 1898, p. 263) and Osgood (Proc. Biol. Soc. Wash., XV, 1902, p. 88), the name becomes applicable to the white-tailed deer of the Valley of Mexico, which has only a distant relationship to the form here described.[1]

According to Mr. Batty these deer are not a "timber" deer, and frequent only the high, almost treeless mountain tops, like the mountain sheep. They are not very common and are hard to approach, in consequence of the open character of the country.

2. **Sciurus apache** *Allen.*

Five specimens, all adult, collected as follows: Cienega de las Vacas, 1 male, April 3; Arroyo de Bucy, 1 male, 3 females, May 20–28. They are quite uniform in size as regards the length of the head and body, but the tail varies greatly. The five specimens measure: Total length, 566 (543–591); head and body, 276 (267–286); tail vertebræ, 292 (264–377); hind foot (without claws), 66 (64–70); ear from notch, 32.6 (32–35).

3. **Eutamias durangæ,** sp. nov.

Type, No. 21410, ♀ ad., Arroyo de Bucy, northwestern Durango, Mexico; J. H. Batty.

Similar to *Eutamias bulleri* from southwestern Zacatecas, but larger and paler, with the white markings on the head broader and the white postauricular patch larger; rump, basal portion of the tail, and flanks faintly suffused with a very pale tinge of buff instead of being gray as in *bulleri;* the dark dorsal stripes are similar in extent and in color, but the intervening light stripes are suffused with pale cinnamon instead of being nearly clear white as in *bulleri*, and the rufous of the flanks is much paler.

[1] As Mr. Osgood (*l. c.*), in his history of the case, shows the validity of the claim that the original *Cervus mexicanus* had no tangible basis, it seems more in accordance with usage in such cases to consider the name *mexicanus* as preoccupied by an indeterminable species, and to recognize the form described and figured by Lichtenstein as entitled to the new name *Odocoileus lichtensteini* which has been bestowed upon it. (*Cf.* Allen, this Bulletin, XVI, 1902, pp. 16 and 20, footnotes.)

Measurements. — Type, total length, 238; tail vertebræ, 98; hind foot (without claws), 32; ear from notch, 19. Nine adult topotypes (5 males and 4 females) measure as follows: Total length, 234 (222–241); head and body, 137.6 (127–140); tail vertebræ, 97.2 (95–102); hind foot, 32.1 (32–33); ear, 19.9 (19–22).

Skull: type, total length, 39; greatest zygomatic breadth, 21. Nine topotypes: Total length, 38.8 (37–40); zygomatic breadth, 20.7 (20–21). Six skulls of *E. bulleri* measure: Total length, 37.5 (37–38.2); zygomatic breadth, 20.1 (20–20.5). (No external measurements of *E. bulleri* are available for comparison, the collector omitting to take measurements before skinning.)

Eutamias durangæ is based on a series of 13 specimens, all adult except two, taken by Mr. Batty at Arroyo de Bucy, in the Sierra del Candella, at an altitude of about 7500 feet, May 22–30. As already noted above, it resembles *E. bulleri*, but is considerably larger, and quite different in coloration, being much lighter colored, with the gray areas faintly suffused with pale buff, and the median white dorsal stripes with a wash of pale cinnamon.

Mr. Batty informs me that this chipmunk is reported to range for some distance to the southward along the eastern base of the Sierra Madre.

4. **Citellus (Otospermophilus) grammurus rupestris,** subsp. nov.

Type, No. 21231, ♀ ad., Rio Sestin, northwestern Durango, Mexico, April 13, 1903; J. H. Batty.

Front, top, and sides of head and the nape black, a few of the hairs with gray or brownish gray tips, more numerous toward the edges of the black area which is not sharply defined; nose as far back as the eyes and cheeks grayish brown, the hairs being blackish brown at base and broadly tipped with whitish; a patch of whitish above and below the eyes, giving the effect of broad white eyelids; whole upper surface of body varied or ringed with blackish brown and whitish, darkest on the anterior half and lightest on the posterior half of the dorsal region, more or less (often strongly) suffused with yellowish brown; sides lighter and grayer than the median area; underfur black or blackish, and the coarser hairs black basally and at the extreme tip, with a subapical broad band of white or whitish; throat, prepectoral, and axial regions ochraceous buff; rest of ventral surface paler or yellowish buff, the hairs dusky at the extreme base; fore feet yellowish gray; hind

feet more strongly yellowish; ears thinly haired, externally black, internally paler, the tips of the hairs rusty brown; tail above grizzled black and white, becoming darker towards the tip, the hairs individually alternately ringed with black and soiled whitish, there being three bands of each, and tipped broadly with clearer white; lower surface of the tail pale yellowish white, striped on each side with three longitudinal bands of black which increase in width from the inner to the outer, the outer being about twice the width of the inner.

Total length (type), 520; head and body, 279; tail vertebræ, 241; hind foot, to end of toes, 57, to end of claws, 64; ear, 25. Skull: Total length, 66; zygomatic breadth, 40; length of nasals, 23; upper toothrow, 13.

The amount of black on the head varies greatly in different specimens, averaging about as above described, but varying from almost none whatever to specimens in which the hairs are black basally with the tips grayish, and through these to clear brownish black; the black area often extends far down over the nape, and occasionally, as a broad median band, to the shoulders, and in one specimen to the middle of the back.

Doubtless in fresh fall pelage the markings would be about as above described, but with all the tints deeper and hence with greater contrast between the light and dark rings of the individual hairs.

As already indicated, in many specimens the pelage becomes not only exceedingly worn before the post-breeding moult, but greatly faded and discolored, even the underfur, where exposed, changing from black or blackish to yellow-brown. With this moult the ventral surface changes from pale ochraceous to whitish, more or less mixed with dusky, the basal portion of the hairs being dusky with long whitish tips, through which the dusky bases are more or less visible.

Many of the specimens are in greatly worn and discolored pelage, the ends of the hairs over the posterior half of the body having been in some instances wholly worn away, leaving only the fulvous brown bases, the terminal portion bearing the alternating dark and light rings having disappeared. In most of these the moult is in progress, in some the coat having been renewed on the front half of the body.

Citellus g. rupestris is represented by 28 specimens, all adult but 3, which are about two thirds grown, collected as follows: Rio Sestin, 18, April 12–19; Rancho Bailon, 10, May 5–11. Throwing out the young examples, and two with defective tails, the remaining 23 measure as follows:

Nine males: Total length, 503 (451–540); head and body, 277 (241–298); tail vertebræ, 233 (210–248); hind foot (without claws), 56.7 (55.5–57); ear, from notch, 26.3 (25–28). Fourteen females: Total length, 499 (463–521); head and body, 272 (254–293); tail vertebræ, 227 (203–241); hind foot, 56 (54–60); ear, 26.3 (25–29).

The two extremes are both old males and measure respectively: Total length, smallest, 451, largest, 540; head and body, 241 and 298; tail vertebræ, 210 and 248; hind foot, 57 in both; ear, 25 and 28. The females average slightly smaller than the males, and present a much less range of variation, none being nearly as small as the smallest male, nor are any as large as the largest males.

This subspecies most resembles *C. grammurus*, but differs from it in being larger, in having the crown and nape (usually) black, the shoulders and sides less white, and the ventral surface deep buff. It is characterized also by a larger and much heavier skull, with heavier dentition. It is very distinct from *C. variegatus* of the Valley of Mexico and contiguous areas, which is a much darker animal throughout, and also larger, and in which the dark crown patch is only incipiently developed. It is more than probable, however, that the whole series of line-tailed spermophiles, from the Valley of Mexico northward to Colorado, will prove to be intergrading forms of the long-known *grammurus* group, as suggested by Mr. Nelson in his note on Erxleben's *Sciurus variegatus*.[1]

At first it seemed probable that this series of Durango specimens must represent *Spermophilus macrourus* of Bennett (P. Z. S., 1833, p. 41), although Mr. Nelson had synonymized it with *Sciurus variegatus* Erxleben, later (1830) renamed *Spermophilus buccatus* by Lichtenstein. Through the kindness of Dr. A. K. Fisher, Acting Chief of the U. S. Biological Survey, I have before me four typical examples of *Citellus variegatus*, collected by Mr. E. W. Nelson in the Valley of Mexico and the adjoining State of Puebla, and a series of exactly similar specimens from Zapotlan, southern Jalisco, collected for this Museum by Dr. Buller. Bennett's description applies much better to this form than to the Durango specimens, and it seems therefore preferable to consider Bennett's *macrourus* as a synonym of *variegatus*, as Nelson has done, or else to regard it as unidentifiable. The final settlement of the case must rest on an appeal to the type, which may still exist in the British Museum.

[1] Nelson, E. W. What is *Sciurus variegatus* Erxleben? Science, N. S., VIII, No. 208, pp. 897, 898, Dec. 23, 1898.

In addition to the Durango series I find in the Museum collection a single specimen from Guadalupe y Calvo, Sierra Madre, State of Chihuahua, collected in 1893 by Dr. Lumholtz.

None of the many specimens from southern Arizona (White Mts., Chiricahua Mts., Fort Lowell, Fairbank, etc.), nor from Colonia Garcia (in the Sierra Madre of Chihuahua), shows any marked tendency toward the present form, which, doubtless, will be found to occur over a considerable area in Sonora and southern Chihuahua, as well as in Durango.

5. **Mus musculus** *Linn.*

Six specimens: Rosario, 1, Jan. 25; San Gabriel, 2, Feb. 18; La Boquilla, 2, Feb. 16; Rancho Santuario, 1, March 2.

6. **Mus rattus** *Linn.*

Two specimens, Rio del Bocas, Feb. 8.

7. **Mus alexandrinus** *Geoffroy.*

One specimen, Mt. San Gabriel, Jan. 8.

8. **Onychomys torridus** (*Coues*).

Four specimens: Rosario, 1, Jan. 24; Villa Ocampo, 1, Feb. 12; Rio Sestin, 2, April 11 and 21. They do not seem to differ appreciably from specimens from southern Arizona.

9. **Peromyscus paulus,** sp. nov.

Type, No. 21165, ♂ ad., Rio Sestin, northwestern Durango, April 17; J. H. Batty.

Smaller than either *P. musculus* or *P. m. brunneus* and different in color. Upper parts gray brown suffused with pinkish buff; under parts grayish white, the base of the hairs being plumbeous and the tips whitish; in some specimens a faint buffy tinge on the belly.

Measurements. — Type, total length, 108; head and body, 62; tail vertebræ, 44; hind foot, without claws, 13, with claws (from dry skin), 14; ear, from notch, 13, from crown (in dry skin), 11. Seven additional males give practically the same measurements as the type; 6 old females are slightly larger, as follows: Total length, 112 (108–117); tail vertebræ, 44.3 (38–48); hind foot, 13 (12–14); ear, 12 (11–13).

Young specimens in first pelage are gray brown, and young adults are darker and more varied with blackish and less suffused with buff than old adults.

Represented by 20 specimens, collected as follows: Rosario, 1 (young), Jan. 26; San Gabriel, 2, Feb. 18 and 20; Rancho Santuario, 2, Feb. 21 and 27; Rio Sestin, 15, April 9–17.

Peromyscus paulus is a northern representative of the *P. musculus* group, but is very much smaller than either *P. musculus* or *P. m. brunneus*, and differs widely from either in coloration, being lighter or grayer above suffused with pinkish buff instead of dark yellowish brown as in *brunneus* or tawny as in *musculus.* It needs no comparison, however, with *P. taylori*, which is still smaller, with smaller ears, shorter tail, and different coloration.

10. **Peromyscus texanus flaccidus,** subsp. nov.

Type, No. 21064, ♂ ad., Rio Sestin (altitude, 7500 feet), northwestern Durango, April 13; J. H. Batty.

Similar to *P. t. arizonæ*, but slightly paler and rather more fulvous, and also larger with a relatively longer tail and shorter hind foot.

Adult in April, upper parts dark fawn brown, darker over the median area, which is slightly varied with blackish, and lighter, clearer fawn on the sides, defined abruptly against the white of the ventral surface without an intervening fulvous lateral line; head paler and grayer than the body, especially over the whole front of the head; underparts clear white with plumbeous underfur; fore legs white to the shoulder; dark color of body extending narrowly down hind limb to tarsal joint; ears very thinly haired, dark gray brown, slightly margined with whitish; tail bicolor, thinly haired and with no very appreciable pencil, the upper third dark brown, the rest grayish white.

Young adults are dark grayish brown without tinge of fawn; young in first pelage are ashy gray varied with black, much lighter gray than young of corresponding age of either *arizonæ* or *sonoriensis;* ears black with a fluffy whitish gray tuft at anterior base.

Measurements. — Type, total length, 177; head and body, 98; tail vertebræ, 79; hind foot, without claws, 19, with claws, 20; ear, from notch, 18, from crown in dry skin, 14. Twenty-one adults (13 males, 8 females) from Rio Sestin: Total length, 172.8 (159–184); head and body, 95 (83–102); tail vertebræ, 77.3 (70–89); hind foot, 19.3 (19–21); ear, 18.6 (17.5–19).

Nineteen adults of *P. t. arizonæ*, from Fairbank, Arizona, strictly comparable as to season and age, average much smaller, having a total

length of 162 (145–181, only 3 above 170) as against 173 for *flaccidus;* tail vertebræ, 72 (59–80, only 3 above 74) as against 79; hind foot, 22.4 as against 20.5.

Represented by 64 specimens, collected as follows: Rosario, 6, Jan. 24 and 25; Rio de las Bocas, 4, Feb. 8 and 9; Villa Ocampo, 3, Feb. 14; La Boquilla, 1, Feb. 16; San Gabriel, 5, Feb. 17–20; Rancho Santuario, 3, Feb. 21–25; Rio Sestin, 42, April 9–14. Among the April specimens are many young, one quarter to nearly full grown, and the January-February specimens contain a few young adults, but consist mostly of adults, showing that the young are not born till some time in March or later.

This subspecies seems to most resemble *arizonæ* of the *texanus* group, but adults are slightly paler and more fulvous, and young in first coat, as well as young adults, are decidedly paler and more ashy gray. The skulls present no distinctive features, but the differences in size, and especially the longer tail and shorter hind foot, seem noteworthy.

Although a pallid form it differs very appreciably in coloration, and also in size, from *P. t. medius* Mearns from the desert coast belt of northern Lower California.

11. **Peromyscus boylii pinalis** (*Miller*).

Represented by 66 specimens, *all adult*, collected as follows: Mount San Gabriel, 5, Jan. 28; La Boquilla, 6, Feb. 14–16; San Gabriel, 12, Feb. 17–20; Rancho Santuario, 24, Feb. 27–March 7; Matalotes, 7, March 23 and 24; La Cienega de las Vacas, 7, March 21–31 and April 6; Arroyo de Bucy, 3, May 23; without locality, 2, and several additional skulls.

Ten adults from San Gabriel measure: Total length, 190 (181–209); head and body, 90.3 (86–98); tail vertebræ, 99.5 (95–114); hind foot (without claws), 19.4 (19–20.5); ear from notch, 19 (17.5–20.5).

These specimens do not differ appreciably from a large series from the southern border of Arizona, either in size, proportions, or coloration.

12. **Sigmodon minimus** *Mearns.*

Twenty-four specimens, as follows: Rosario, 9, Jan. 21–29; Rio Sestin, 11, April 6–16; Rancho Bailon, 4, May 4–10.

They are mostly young adults, but include 2 middle-aged adults and 1 very old female. If these specimens are rightly referred to *S. minimus*, they show that *minimus* may, when old, attain nearly the size of *S. fulviventer*, from which, however, it differs widely in coloration. The old female and the two middle-aged specimens (male and female) measure, respectively, as follows: Total length, ♀ 269, ♂ 238, ♀ 228; tail vertebræ, 114, 95, 98; hind foot, without claws, 29, 25, 24 (with claws about 3 mm. more); ear from notch, 18, 18, 19.

The Durango series averages rather grayer, with darker (less brownish apically) underfur, than several Arizona specimens available for comparison, and may prove subspecifically separable.

13. **Sigmodon baileyi**, sp. nov.

Type, No. 20993, ♀ ad., La Cienega de las Vacas (altitude 8500 feet), northwestern Durango, March 27; J. H. Batty.

Pelage rather soft. General color of upper parts gray brown, nearly without fulvous suffusion, the sides faintly tinged with pale buff, the long hairs of back and sides tipped with soiled white, mixed abundantly with black-tipped hairs; underparts white, the basal portion of the hairs ashy plumbeous; *sides of nose conspicuously ochraceous buff;* region at base of tail suffused with cinnamon buff; ears rather dark gray on both surfaces; soft woolly hair at posterior base of ears pale buff; feet pale buffy gray; tail well-haired, bicolor, blackish brown above and all around for apical fourth, pale buffy gray below.

Total length (type), 198; tail, about 90 (slightly imperfect); hind foot (without claws), 25; ear (from notch), 18. Skull, total length, 31.5; basal length of Hensel, 27.3; nasals, 12.5; zygomatic breadth, 18.3; mastoid breadth, 13.3; alveolar length of upper molar series, 5.6.

Represented by 5 specimens: the type, from La Cienega de las Vacas; 3 young adults from Rancho Santuario, Feb. 26 and March 1; and 1 young adult from Arroyo de Bucy, May 30. The type is an adult female that appears to have raised young; the teeth are considerably worn and the skull has well-developed ridges.

Sigmodon baileyi is a very gray, conspicuously yellow-nosed form, apparently closely resembling *Sigmodon hispidus major* in general coloration, but very much smaller—at least one half smaller in general bulk. It belongs to the same group as *Sigmodon hispidus arizonæ* Mearns and *S. h. major* Bailey, which appear to be both specifically separable from true

hispidus, as, respectively, *Sigmodon arizonæ* and *S. a. major*, with which perhaps *S. baileyi* should be associated. Named for Mr. Vernon Bailey, who has done so much to establish order in this very puzzling group.

14. **Reithrodontomys megalotis sestinensis,** subsp. nov.

Type, No. 21175, ♂ ad., Rio Sestin (altitude, 7500 feet), northwestern Durango, April 11; J. H Batty.

Similar in general coloration to *R. megalotis*, but upper parts more strongly varied with black and less fulvous, and with relatively longer tail. Type, total length, 139; head and body, 70; tail vertebræ, 69; hind foot, 18; ear (from notch), 14. An adult female: 139, 69, 70, 18, 14.

Represented by 4 specimens taken as follows: Rosario, 1, Jan. 25; Rio Sestin, 3, April 11–15.

The white underparts and much smaller size distinguish this form from *R. m. obscurus* Merriam, from near Guadalupe y Calvo, Chihuahua, on the western side of the Sierra Madre. While similar in size to *R. m. deserti* Allen, from Nye County, Nevada, it differs from it in much darker coloration.

15. **Neotoma intermedia durangæ,** subsp. nov.

Type, No. 21185, ♂ ad., San Gabriel (altitude, 7000 feet), northwestern Durango, Feb. 20; J. H. Batty.

Externally similar to *Neotoma intermedia albigula* Hartley, but averaging rather larger, with a shorter and broader skull and much heavier dentition.

Measurements. — Type, total length, 356; head and body, 197; tail vertebræ, 159; hind foot, without claws, 32, with claws, 33; ear, from notch, 30, from crown in dry skin, 25. Four additional males: Total length, 345 (330–356); tail vertebræ, 156.5 (152–162); hind foot, 32; ear from notch, 29.5 (29–30). Skull, total length, 45; basilar length of Hensel, 38; length of nasals, 18; zygomatic breadth, 24; width of braincase at posterior base of zygoma, 18.5; mastoid breadth, 18; interorbital breadth, 6; length of upper toothrow, 9.

Represented by 21 specimens, collected as follows: Mt. San Gabriel, 9, Feb. 18–20; Rancho Santuario, 6, Feb. 22–24 and March 6; La Cienega de las Vacas, 1, March 30; Rancho Bailon, 4, May 10; Arroyo de Bucy, 1, May 24.

Compared with a good series of topotypes of *N. intermedia albigula*, the skull of *N. i. durangæ* averages about 2 mm.

shorter and nearly 2 mm. wider, with very much heavier dentition (molars much broader), and a shorter and more strap-shaped interparietal. In coloration and external measurements the two forms are similar, but *durangæ* is less fulvous. It perhaps should be compared with *N. i. melanura* Merriam, from Ortiz, Sonora, from which, however, it appears to differ in having a larger head and body and much shorter tail, and by the absence (generally) of an antero-internal sulcus on m^1. No skull measurements were given of *melanura*, but the skull is described as smaller, with narrower nasals, than *albigula*, which is not the case with *durangæ*.

16. **Thomomys sinaloæ** *Merriam.*

Rio Sestin, 1 specimen, April 11.

17. **Thomomys,** sp.

Two specimens: Mt. San Gabriel, 1, Jan. 28; Matalotes, 1, March 20. They differ widely in coloration and probably represent two species, but the skull of one is too much broken for use in comparison.

18. **Perodipus obscurus,** sp. nov.

Type, No. 20957, ♂ ad., Rio Sestin, northwestern Durango, April 13; J. H. Batty.

General color of dorsal area gray brown slightly suffused with fulvous, resulting in a faintly olive gray brown effect; flanks more strongly suffused with fulvous, which is here the prevailing color; lower parts, including fore limbs, lower half of cheeks and sides of neck, clear white to base of hairs; tip of nose and a narrow line running back on each side of base of whiskers black; exterior surface of ears buffy whitish, nearly white apically and at base, antero-external border and inner surface blackish; small spot above eyes, postauricular patch, and oblique band on thighs white; outside of hind limbs to the tarsal joint like the back, inside white, soles dusky brown; tail with the sides and a basal ring white, the upper and lower surfaces blackish from base to tip, the upper surface heavily crested for about the terminal third.

Measurements. — Type, total length, 232; head and body, 102; tail vertebræ, 130; hind foot, without claws, 32, with claws, 35; ear from notch, 12.7. Skull with a broad rostrum, as in *P. agilis*, with

which species the skull closely agrees in general form; total length, 36; greatest mastoid breadth, 23; length of nasal, 13. As regards size, out of 40 adults only 4 exceed a total length of 240 (maximum, 250), and only 6 have a tail length of 136 or above (maximum, 140). Even the maximum size falls far below the minimum for adults of *P. agilis*.

Represented by 84 specimens, collected as follows; Rosario, 28, Jan. 24–27; Mt. San Gabriel, 2, Jan. 28; Rio del Bocas, 13, Feb. 8–9; Villa Ocampo, 5, Feb. 13; Rancho Santuario, 1, Feb. 22; Rio Sestin 35, April 9–17.

Twenty adults (12 males and 8 females), from Rio Sestin, measure as follows: 12 males, total length, 234 (223–244); head and body, 101.7 (98–111); tail vertebræ, 131 (121–136, only 2 below 130); hind foot (without claws), 32.4 (32–33); ear from notch, 13.2 (13–14): 8 females, 225.5 (218–238); 101.3 (98–105); 123.4 (120–133); 32.5 (32–33); 13.7 (13–14).

Nine males from Rosario: Total length, 229.6 (222–232, with 1 additional 250); head and body, 103 (95–114, with only 1 above 105); tail vertebræ, 126.7 (121–136, with only 1 above 130); hind foot, 34.6 (34–35); ear, 13.1 (13–14).

Eleven specimens (6 males and 5 females), from Rio del Bocas: 6 males, total length, 232.5 (223–245); head and body, 103.7 (102–105); tail vertebræ, 129 (121–140); hind foot, 34.5 (32–36); ear, 13.5 (13–14); 5 females, 230 (222–245); 103.2 (102–105); 127 (120–140, only 1 above 134); 33.8 (32–36); 13.5 (13–14).

Perodipus obscurus is the darkest-colored species of the genus thus far known, except possibly *O. agilis*, which has, however, a very different coloration, and is nearly double the size of the present species, which about equals *O. ordi* and *O. chapmani*. From all the smaller members of the group it differs too radically in coloration to require special comparison.

19. **Perognathus flavus** *Baird.*

Six specimens: Rancho Santuario, 1, Feb. 21; Rio Sestin, 5, April 16 and 17.

20. **Perognathus nelsoni** *Merriam.*

Ten specimens, as follows: San Gabriel, 2, Feb. 19 and 20; Rancho Santuario, 6, Feb. 22–March 8; Rio Sestin, 2, April 11.

Seven adult males measure: Total length, 178 (162–190); head and body, 82.4 (76–89); tail vertebræ, 99 (95–102);

hind foot (without claws), 19.8 (19–22); ear from notch, 8.5 (8–9.5).

These specimens are rather grayer and paler than August topotypes of *P. nelsoni*, but the difference is probably seasonal.

21. **Liomys canus** *Merriam.*

Ten specimens, collected as follows: Rosario, 6 young adults, Jan. 21–27; Rio Sestin, 4 adults, April 9–15. The January specimens are uniform dark gray above, with a pale yellowish lateral line; the April specimens are much paler gray, some of which have a distinct lateral line, while in others the line is obsolete. Two of the April specimens are beginning to moult, in one of which the pelage of a large part of the dorsal area has been renewed; the new pelage is much darker and mixed with fulvous, and closely resembles that of September topotypes of *L. canus* from Parral, Chihuahua, which locality is only about fourteen miles north of Rosario. These specimens are therefore almost topotypes of *L. canus*, but as a series they differ so widely from late September specimens of the latter that they might readily be mistaken for a different species. The difference, however, is obviously seasonal, and emphasizes the importance, in instituting comparisons between allied forms, of using material strictly comparable as to season. Rarely, perhaps, is such a wide range of seasonal variation met with as in the present species.

Three adult males measure, respectively, as follows: Total length, 244, 248, 252; head and body, 124, 130, 130; tail vertebræ, 114, 124, 122; hind foot (without claws), 31, 31.5, 31.5; ear (from notch), 17.5–18.3.

22. **Lepus (Macrotolagus) texianus micropus,** subsp. nov.

Type, No. 21251, ♂ ad., Rio del Bocas, northwestern Durango (altitude, 6800 feet), Feb. 12; J. H. Batty.

Similar to *L. texianus eremicus* Allen, and *L. texianus griseus* Mearns, but more brownish gray than the latter, and larger bodied,

with shorter tail, smaller hind feet, and larger ears than either, and with less fulvous along the sides of the body; prepectoral area paler and more grayish.

Measurements. — Type, total length, 535; head and body, 459; tail vertebræ, 76; hind foot, 114; ear from notch, 133; ear from crown, 175.

Represented by 19 specimens (8 males and 11 females), collected as follows: Rancho Santuario, 1, Feb. 2; Rio del Bocas, 5, Feb. 9–12; Rio Sestin, 1, April 18; Rancho Bailon, 12, May 5–13. As usual in the species of *Lepus*, the males are considerably smaller than the females, as shown by the following measurements, which include the whole Durango series:

Eight males: Total length, 564 (535–587); head and body, 493 (459–514); tail vertebræ, 71 (64–83); hind foot, 116 (108–127); ear (from notch), 136.4 (133–146).

Eleven females: Total length, 599 (559–626; only 1 below 578, and only 2 above 610); head and body, 524 (483–546); tail vertebræ, 73.7 (64–89); hind foot (without claws), 118 (108–124); ear (from notch) 137 (130–145; only 1 above 140).

This subspecies may be best compared with *L. texianus griseus* of Mearns, the type locality of which is Fort Hancock, El Paso County, Texas, inasmuch as I have a large series of this form from the southern border of New Mexico, taken near El Paso, collected and measured by Mr. Batty, and thus strictly comparable in measurements with his series of Durango specimens here under consideration. According to the same collector's measurements, 10 females of *griseus* have a head and body length of 460 as against 599 for 11 females of *micropus;* tail vertebræ 82 in *griseus* as against 74 in *micropus;* the hind foot 128 as against 118 in *micropus;* and the ear from notch 130 in *griseus* as against 137 in *micropus.*

Some of the May specimens are in worn pelage, but the coloration, in general effect, differs but little from that of the February specimens. The wearing away of the light tips to the hairs leaves the back darker, and the fulvous of the prepectoral area is duller and grayer, or less fulvous.

This form needs no comparison with *Lepus asellus* Miller, from San Luis Potosi, which belongs to the group with black at the base of the ears, of which there is no trace in the *texianus* group.

23. **Lepus (Microtolagus) gaillardi battyi,** subsp. nov.

Type, No. 21257, ♂ ad., Rancho Santuario, northwestern Durango, Mexico, Feb. 17, 1903; J. H. Batty.

Similar to *L. gaillardi* Mearns, but much smaller, the general coloration yellower and less rufescent, especially the underfur. Prepectoral collar much paler, nearly white or pale brownish white instead of buff; front of fore feet grayish white instead of buffy white, and upper surface of hind feet clearer or purer white. Extreme terminal portion (about 25 mm.) of anterior border of ear blackish in both forms.

Measurements. — Type, total length, 511; head and body, 451; tail vertebræ, 60; hind foot (without claws), 122; ear, from notch, 127, from crown, 140. Three adult males, same place and date, measure as follows: Total length, 501.5 (465–530); head and body, 451 (432–470); tail vertebræ, 61 (60–64); hind foot, 121 (119–124); ear from notch, 123 (115–133). The corresponding measurements of 3 specimens (1 male, 2 females) of *L. gaillardi*, as given in the original description are: Total length, 1 male, 530, 2 females (average), 567; tail vertebræ, 77, 86; hind foot (to end of claws), 131, 135; ear, from notch, 123, 127, from crown, 146, 148.

Skull. — Type, total length, 92; basal length, 82; zygomatic breadth, 44; greatest breadth across supraorbital processes, 31; postorbital constriction, 11; length of nasals, 40; anterior width of nasals, 11; posterior width of nasals, 20; palatal length (including point on anterior border of palatal floor), 9; length of premolar-molar series (at alveolar border), 17. Another skull measures practically the same in all dimensions, while a third (evidently younger) is 4 mm. shorter in total length, and proportionally smaller in all other dimensions except length of toothrow.

Three adult males, collected at Rancho Santuario, northwestern Durango, Feb. 17, 1903, have been compared with two of the original topotypes of *Lepus gaillardi*, collected on the boundary line of New Mexico and Chihuahua, and while essentially similar in general features, the Durango specimens are readily distinguishable by the coloration of the dorsal area, especially as respects the underfur, and also of the prepectoral band, and the anterior surface of the fore limbs and tarsi, these parts, as indicated above, being distinctly paler; the general size is also much less, as shown in the foregoing measurements.

This species is evidently rare in northern Durango, and was met with over a very limited area.

24. Lepus (Sylvilagus) arizonæ major *Mearns.*

Seventeen specimens, all but 4 adult, collected as follows: Matalotes, 1, March 20; Rancho Bailon, 16, May 5–12.

Five males measure: Total length, 355 (346–372); head and body, 312 (298–324); tail vertebræ, 43 (32–50); hind foot (without claws), 74 (70–76); ear from notch, 69.3 (69–70); 9 females, total length, 365 (344–388); head and body, 327 (308-343); tail vertebræ, 43.7 (38–50); hind foot (without claws), 74 (70–76); ear from notch, 68 (63.5–70).

According to the measurements taken from the fresh specimens by the collector, who collected and measured both series, the Durango specimens slightly exceed those from southern New Mexico (*L. a. minor*, from near El Paso, Texas) in all the measurements except that of the hind foot, which falls a little below that of the New Mexico series. The Durango specimens are very much paler, being less varied with black, and having the brownish tint of the ground color much paler. Owing to the larger size of the Durango specimens, they are referred to Mearns's subspecies *major*. The smaller size of the hind foot is paralleled in the *Lepus texianus* series from the same two regions. The measurements may be thus tabulated for comparison:

L. a. minor: 12 males, total length, 343; tail vertebræ, 40; hind foot, 77; ear, 65.4.

L. a. major: 5 males, total length, 355; tail vertebræ, 43; hind foot, 74, ear, 69.3.

L. a. minor: 10 females, total length, 347; tail vertebræ, 41; hind foot, 76; ear, 66.

L. a. major: 9 females, total length, 365; tail vertebræ, 43.7; hind foot, 74; ear, 68.

As the *minor* series was taken in December, and the *major* series in May, it is possible that the average may be affected by the fact that the December series may contain some 'young adults' which by the following May would have increased in size; but the improbability that this is the cause of the difference in average size is shown by comparison of the maxima of the two series, which differ correspondingly with the averages.

25. **Lepus (Sylvilagus) durangæ,** sp. nov.

Type, No. 21377, ♀ ad., Rancho Bailon (altitude, 7800 feet), northwestern Durango, May 12, 1903; J. H. Batty.

Size of *Lepus insolitus* Allen, from the Plains of Colima, State of Jalisco, but much less varied with black and the general coloration much paler, except the nape patch, the legs and feet, which are of the same deep rufous as in *L. insolitus*. In other respects the general coloration is not distinctly different from that of *L. arizonæ major* Mearns, collected at the same locality. From the latter it differs in being twice as large (in general bulk), and from both *L. insolitus* and *L. a. major* in important cranial characters.

Measurements. — Type, total length, 457 (as against 327 in *L. a. major*); head and body, 406; tail vertebræ, 51; hind foot (without claws), 95; ear (from notch), 76. The type and two paratypes measure as follows: Total length, 436 (419–457); head and body, 387.6 (356–406); tail vertebræ, 55 (51–63); hind foot, 93 (89–95); ear, 76 (73–79). Skull: Total length, 79 (as against 65 in *L. a. major*); basilar length, 60; zygomatic breadth, 36.3 (as against 32 in *L. a. major*); length of nasals, 35; width of nasals posteriorly, 16; anteriorly (= width of rostrum), 9; alveolar length of upper toothrow, 13.3; length of lower jaw, 55; height at condyle, 30; alveolar length of lower toothrow, 13.6. Skull similar in general contour to that of *L. a. major*, but very much larger, with actually smaller audital bullæ, which are hence proportionally at least one third smaller. Skull much less massive than that of *L. insolitus*, and so widely different in all details that no comparison is necessary.

Represented by three adult females, taken as follows: Rancho Bailon, 1 specimen, May 7; Arroyo de Bucy, 2 specimens, May 12 and 20.

This is a member of the *Sylvilagus* group, distinguished by large size and important cranial characters, especially the greatly reduced audital bullæ. It is recorded by the collector in his field notes as 'Mountain Rabbit,' the smaller *L. a. major*, found with it, being called 'Mesquit Rabbit.' It is about the size of *L. aztecus* Allen from Tehuantepec, which has a much broader rostrum, and still smaller bullæ, and is otherwise quite different in cranial details. It is also rather smaller and much darker in coloration. It is, perhaps, more closely allied to this species than to *L. insolitus*.

26. **Canis impavidus,** sp. nov.

Type, No. 21266, ♂ ad., Rio del Bocas (altitude, 7000 feet), northwestern Durango, Mexico, Feb. 13, 1903; J. H. Batty.

Similar in coloration to *C. cagottis* (Ham. Smith), but much larger, and the upper carnassial with a prominent protocone; in size and dental characters similar to *C. mearnsi*, but much paler, the throat and ventral region only slightly suffused with pale fulvous instead of buffy ochraceous, and fore and hind legs and feet not "bright orange fulvous all around," but fore legs posteriorly and hind legs and feet anteriorly pale fulvous, or pale yellowish white, as in *cagottis*.

Measurements. — Type, total length, 1143; head and body, 838; tail vertebræ, 305; hind foot (in dry skin), 178. Skull, total length, 190; basilar length of Hensel, 163; palatal length, 89; zygomatic breadth, 93; mastoid breadth, 59; length of crown of upper carnassial, 19.3.

The collector's external measurements of 7 adults are as follows: 3 males, total length, 1189 (1130, 1143, 1295); head and body, 855 (800, 838, 927); tail vertebræ, 334 (330, 305, 368); hind foot, 178 (given for one specimen only); ear from crown, 152 (1 specimen): 4 females, total length, 1123 (1105–1181); head and body, 806 (787–826); tail vertebræ, 341 (305–368); hind foot (not given); ear from crown, 138 (127–146).

Skull measurements of 4 males and 4 females: 4 males, total length, 195.6 (190–202); basilar length of Hensel, 170 (163–173); palatal length, 91.6 (89–93); zygomatic breadth, 93.5 (93–94; 2, the two largest being imperfect); mastoid breadth, 60.7 (59–62); length of crown of upper carnassial tooth, 19.7 (18.6–20.5): 4 females, total length, 190.5 (189–193); basilar length of Hensel, 166.3 (164.3–169); palatal length, 91.5 (90–94); zygomatic breadth, 95 (92–97); mastoid breadth, 59.4 (58–60.5); length of crown of upper carnassial, 18.3 (17.3–19.5). Six of the specimens are middle-aged adults; the other two (a male and female) are old adults with greatly worn teeth. In each case these two specimens are, respectively, the largest of the two series.[1]

The young specimens (so young that the eyelids remain tightly closed in the skins, even after the process of skinning) have the front of the head as far back as the eyes, including sides of nose and chin, blackish brown; the rest of the head and body dark buffy brown, nearly black along the median line of the back, lighter on the sides of the body and beneath, with a large white pectoral area, varying in size, shape, and in the purity of the white in different individuals; limbs and tail blackish, like the nose.

[1] The old male skull is especially interesting pathologically, on account of an accident, received apparently in early life, to the right side of the skull, resulting in a fracture of the zygomatic arch and serious injury to the right ramus. The broken parts of the arch became displaced and failed to unite, resulting in their partial atrophy and a marked asymmetry of the skull, including an axial curvature to the left. The axis of the right ramus is also curved inward instead of outward, and, with the loss of the last two premolars, has undergone more or less atrophy. Yet the specimen, in both external and cranial measurements, is the largest of the series. Externally the head shows no sign of injury.

Represented by 8 adults (7 skins and an additional skull) and 7 newly born young, collected as follows: Villa Ocampo, 2 males, Feb. 13; La Boquilla, 1 female, Feb. 14; Rio Sestin, 1 male and 2 females, April 16–19; Rancho Bailon, 1 female and 7 young (a few days old), May 8 and 14. The February specimens are in good pelage; the April and May ones are somewhat worn and faded.

It is with much hesitation that I add a new name in a group so imperfectly known as the Coyotes, but the present series of specimens from northwestern Durango are clearly not the *C. cagottis* of eastern Mexico, nor are they referable to *C. mearnsi* from southern Arizona. In some respects they combine the characters of both, but not in an intermediate sense.

In the valley of the Rio Sestin, says Mr. Batty in his notes, "the coyotes greatly annoy the ranchmen in the winter months. They are very bold, often entering corrals in the daytime, killing calves, sheep, and goats. I have known them to take small pigs from the steps of the squatters' huts." He also refers to a night attack on his camp by a pack of about twenty coyotes, who dragged away five deer skins from within twenty feet of where he was lying. Three paid the penalty with their lives and form part of the specimens above enumerated.

27. **Mephitis macroura milleri** *Mearns.*

Two specimens, females, collected, respectively, at Rio Sestin, April 17 (with *M. estor*), and at Rancho Bailon, May 4.

28. **Mephitis estor** *Merriam.*

Three specimens, 2 males and 1 female, collected as follows: La Cienega de las Vacas, 1 male, April 1; Rio Sestin, 2 (male and female), April 17.

29. **Procyon lotor hernandezii** (*Wagler*).

A single skull, "found on the prairie," at Rancho Santuario.

30. **Myotis incautus** (*J. A. Allen*).

Sixteen specimens: Rio Sestin, 2 (skins), April 16; San Gabriel, 14 (in formalin), June 16.

31. **Myotis californicus durangæ**, subsp. nov.

Type, No. 21459, ♀ ad., Rio Sestin, northwestern Durango, April 15; J. H. Batty.

Like *M. c. ciliolabrum* except in color. Upper parts pale fawn brown (between drab and ecru drab of Ridgway); under parts grayish white; fur at base everywhere dark plumbeous; ear brownish black, much paler than in *ciliolabrum;* muzzle blackish.

Measurements. — Type, total length, 76; tail vertebræ, 33; forearm, 33; longest finger, 54; tibia, 15; foot, 7; ears from meatus, 13.5. Five other specimens, collected at the same time and locality, vary but slightly from the above, the extremes varying only 4 mm. in total ength and 2 mm. in the length of the forearm.

Represented by 6 skins and skulls taken at Rio Sestin, April 15, and 6 in formalin collected at San Gabriel, June 16.

This subspecies presents a very distinct type of coloration in the *Myotis californicus* group, intermediate between that of *M. c. mexicanus* and *M. c. ciliolabrum*, but very different from either. It agrees in size very closely with *ciliolabrum.*

32. **Vespertilio fuscus** (*Beauvois*).

Two specimens, Arroyo de Bucy, May 22 and 24. Expanse, 318 and 320. Not appreciably different from Arizona specimens.

33. **Antrozous pallidus** (*Leconte*).

One specimen, adult male, Rio Sestin, April 13. Expanse, 362; total length, 102. Paler, and whiter below than Arizona and Texas specimens.

34. **Nyctinomus mohavensis** *Merriam.*

Three specimens, Rio Sestin, April 13 and 16. Provisionally referred to *mohavensis.*

MULBERRY CAÑON.

Showing horizontal position and continuity of strata on opposite sides of the Cañon.

Article XXV. — A NEW DEER AND A NEW LYNX FROM THE STATE OF SINALOA, MEXICO.

By J. A. Allen.

A few years since, the Museum purchased a few mammals from Mr. J. H. Batty, collected by him at Escuinapa, southern Sinaloa, in December, 1895. Among the species represented are *Lepus insolitus* Allen, *Canis vigilis* Merriam, and the Lynx and Deer here described. Both are well-marked forms that appear to have hitherto escaped notice.

Odocoileus sinaloæ, sp. nov.

Type, No. 14334, ♂ 2d year, Escuinapa, southern Sinaloa, Mexico, Dec. 15; J. H. Batty.

General color above yellowish gray brown, the top of the head only a little darker than the back; no dark median dorsal band, but middle region of the back darker than the flanks; the hairs individually are light ashy brown for the basal two-thirds, then pass into blackish and are subapically ringed with deep buff and minutely tipped with black; axillary and inguinal regions, posterior face of upper part of fore legs, and inside of thighs white; a broad black band above nose pad, not reaching the lips; no black band or spots on the chin; sides of nose, a broad space behind nose band, and a broad, poorly defined eyering gray; chin and throat buffy grayish white; ears heavily clothed externally and colored like the back, with a very narrow blackish edging on the anterior border; inside of ears thinly clothed with whitish hairs, forming a fringe on the anterior border; tail long, bright rufous above, white below; limbs buffy brown anteriorly, yellowish white on the sides and posteriorly below the carpal and tarsal joints.

Measurements.—Approximate from flat skin: total length, 1435 mm.; tail vertebræ, 175; hind foot, 340; ear from anterior base, 145; ear from notch, 117.

Skull. — Nasals short and narrow; lachrymal pit rather deep and imperforate; antorbital vacuities exceedingly large, nearly twice as large as in *O. toltecus* of corresponding age and size; premaxillaries terminating about 12–15 mm. from nasals; audital bullæ large, the two diameters nearly equal. Total length (male, 2d year), 215; basal length of Hensel, 200; occipitonasal length, 182; length of nasals, 56; zygomatic breadth, 91; width of frontals at anterior border of orbit, 54.5; width of constriction at base of horns, 69; mastoid breadth, 65; alveolar length of upper premolar-molar series, 70. The antlers are slender spikes, 45 mm. long in one specimen and 88 mm. in the other.

This species is based on the skins and skulls of two young males (probably in the second year — the last molar just cutting the gum), collected at Escuinapa, southern Sinaloa, Dec. 11, and hence in full winter coat. In size they resemble specimens of *O. toltecus* of corresponding sex and age, but differ widely from them in coloration and cranial characters. *O. acapulcensis*, its nearest geographical ally on the Pacific Coast of Mexico, is much smaller and very different in coloration and other characters.

Lynx ruffus escuinapæ, subsp. nov.

Type, No. 14326, ♂ ad., Escuinapa, Sinaloa, Mexico, Dec. 24, 1895; J. H. Batty.

General color above pale rufous varied with gray, darker on the back and lighter on the sides, the middle of the dorsal region sharply striped and spotted with black, the sides, from shoulders to hips, with larger spots of duller brownish black; along the median line of back a nearly continuous band of black, made up of two parallel, narrow, more or less interrupted lines of black; nape and top of shoulders more strongly rufous and less gray than the rest of the dorsal surface; top of head prominently streaked and spotted with black; front and sides of head gray, mixed with pale rufous, with a narrow black eyering nearly encircled by a broad outer somewhat imperfect ring of grayish white; middle lateral portion of upper lip strongly marked with black; sides of neck below the ear broadly striped with black; back of ears black, with a triangular patch of whitish gray extending inward from the outer margin and along the edge to the outer base; inside of ears pale buffy gray; fore limbs externally pale rufous, prominently blotched with black, the spots becoming smaller distally and the general color paler; inner side whitish, with broad half-rings and spots of black; hind limbs similar, but the black spots much larger on the proximal portion; middle of soles of hind feet darker than the edges, but not forming a broad central blackish stripe as in most of the other members of the group; ventral surface white, with a broad prepectoral pale rufous band, and a slight buffy suffusion over the middle portion of the abdomen; the whole ventral area, but especially the pectoral region, heavily blotched with black; upper surface of tail like back, with a broad apical half-ring of black, preceded by a narrow transverse spot of black, and with proximally several paler half-rings of blackish brown; middle of tail below white, which also shows as a slight white tip. Although killed in midwinter (Dec. 24), the pelage is very short and coarse in comparison with the more northern forms of the group, and is immensely different from the long, soft, silky coat of *L. baileyi*.

Measurements (from a well-made skin, the flesh measurements not being at present available).—Total length, 805 mm.; tail vertebræ, 117; hind foot, 160; ear from notch (probably shrunken), 55. Skull, total length, 115; basilar length of Hensel, 94; palatal length, 41; nasals (imperfect); zygomatic breadth, 78; interorbital breadth, 22; breadth across postorbital processes, 52; mastoid breadth, 52.3; breadth between outer corners of upper carnassials, 45.5; length of upper carnassial, 14.6.

Lynx r. escuinapæ is distinguished from winter specimens of *L. r. californicus* and *L. r. texensis* by smaller size, shorter and coarser pelage, more rufous and less gray coloration, the greater abundance of black spots and streaks on the back, and the absence of the black soles.

UPPER MULBERRY CAÑON.

Showing typical Miocene Scarp.

Article XXVI. — THE FRESH-WATER TERTIARY OF NORTHWESTERN TEXAS. AMERICAN MUSEUM EXPEDITIONS OF 1899–1901.

By J. W. Gidley.

Plates LII–LVIII.

In the spring of 1899 Professor Henry F. Osborn sent an expedition, under the leadership of the writer, to the Llano Estacado or Staked Plains in northwestern Texas, for the purpose of exploring the Miocene, Pliocene, and Pleistocene beds previously reported from that region by Professor E. D. Cope and Mr. W. F. Cummins, of the Texas Geological Survey. This expedition met with such success that a second and third expedition were sent to this region in the successive summers of 1900 and 1901. The results of the work of the three years are comprised in this report.

The following brief itinerary of the three expeditions seems necessary to a clearer understanding of the region explored and the relations of the different localities visited.

Expedition of 1899.

Clarendon, the county-seat of Donley County, a little town on the Fort Worth and Denver City Railway, was the chief base of outfitting and supplies, and the initial starting-point of the three expeditions.

The writer, with Mr. Alban Stewart as assistant and Mr. Alfred Brown as cook and teamster, left Clarendon July 1, 1899. Going north about ten miles the first camp was established on Barton Creek, where a thorough exploration of the surrounding country was made.

As reported by Cope and Cummins, the beds occupying the tops of the divides in this vicinity are true Miocene and, though of not great vertical thickness nor extensively exposed, are very rich in fossil remains. Several good fossils were found at this locality, the most important being a partial skeleton, in a splendid state of preservation, of *Mastodon*

productus (No. 10582, American Museum Collection) including the skull and lower jaws.

Leaving this locality the party returned to Clarendon, then going west about twenty-five miles to the head of Mulberry Cañon turned southeast about three miles and established a camp at the top of the bluffs a little to the west of the mouth of the cañon. It was at this locality that Cope and Cummins reported a new geological horizon which Cummins called the 'Goodnight Beds' and which Cope considered the same as the Paloduro beds, placing them, in time, between the Loup Fork (Miocene) and Blanco beds which are true Pliocene.

The party remained several days in this locality and the writer explored both sides of the cañon for its entire length, failing to find any evidences of a break in the stratigraphic continuity of the deposits on opposite sides of the cañon, as reported by Cummins.

From Mulberry Cañon the party traveled southeast, crossing the South Fork of Red River near the mouth of Mulberry Creek, continuing south to a point nearly due east of Silverton, the county-seat of Swisher County, turned west and ascended the steep and rugged escarpment to the top of the Staked Plains. Continuing west, passing the head of Rock Creek, a third camp was established at the head of Tule Cañon.

The deposits here and extending east to and beyond Rock Creek on the south side of the cañon, and for some distance along the north side of the cañon as well, are of Pleistocene formation. At the head of Tule Cañon was found a specimen of *Elephas imperator* (No. 10598, American Museum Collection), consisting of a complete fore limb, part of the fore foot, the lower jaw and upper teeth, besides a few vertebræ and ribs.

Returning to the head of Rock Creek, seven miles to the east of the Tule Cañon camp, the party established a fourth camp. At this locality was made the splendid find of fossil horse skeletons (*Equus scotti*) already described by the writer.[1]

This practically ended the season's work, the party returning to Clarendon by the way of Canyon City at the head of

[1] Bull. Am. Mus. Nat Hist., Vol. XIII, pp. 114–116; Vol XIV, pp 134–137.

Paloduro Cañon, then to Amarillo and back along the line of the railroad.

EXPEDITION OF 1900.

The writer was accompanied on the second expedition by Mr. Hans W. Zinsser, of Columbia University, who proved both a valuable assistant and agreeable companion.

A little preliminary work was done this year at the old locality north of Clarendon, but the main object of this expedition was to explore the eastern escarpment of the Staked Plains south from Silverton, and especially to examine the Blanco beds at Mount Blanco. Accordingly the party, leaving Clarendon July 26, 1900, started southwest, taking nearly the route followed the previous year as far as the main divide between Mulberry Creek and South Fork of Red River, then crossing the South Fork of Red River, several miles west of the crossing point of the previous year, ascended the steep escarpment to the top of the Staked Plains at a point nearly north of Silverton. Going east about fifteen miles to the point at which the party ascended the previous year, we turned south along the top of the escarpment, examining the bluffs for a distance of forty or fifty miles, then taking a southwest course across the Plains went direct to Mount Blanco.

The exposures at Mount Blanco are true Pliocene, and, though of small extent, are very rich in fossil remains. The specimens of most importance found at this locality were a nearly complete skull and lower jaws of *Dibelodon mirificus* (No. 10622, American Museum Collection), and, the following year, a partial skeleton of a Glyptodont consisting of a nearly complete carapace, tail pieces, pelvis, sacrum, lumbar and caudal vertebræ. This specimen has since been described by Professor Henry F. Osborn,[1] under the name *Glyptotherium texanum*, gen. et sp. nov.

On finishing the work at this place the party went directly north to the head of Rock Creek, where a second excavation was made in the bank or quarry, from which the horse skele-

[1] Bull. Am. Mus. Nat. Hist., Vol. XIX, 1903, pp. 491–494.

tons were taken the previous year, resulting in the finding of additional material of *Equus scotti* (Nos. 10628, 10629 and 10630, American Museum Collection).

Finishing up the season's work here the party again returned to Clarendon, practically by the same route followed the previous year.

Expedition of 1901.

The third expedition to the Staked Plains was made possible by the kind generosity of Mr. William C. Whitney, who donated a sum to the American Museum to be used, under the direction of Professor Henry F. Osborn, for the collecting and placing on exhibition of fossil horse material to illustrate the evolution of the horse in America. The object, therefore, of this last expedition was to make a more extended exploration of the Miocene and Pliocene exposures with the hope of obtaining some new material of the three-toed horses of these periods.

Accompanied by Mr. William Kendal as assistant and Mr. James Morton as cook and teamster, the writer left Clarendon July 1, going first to the old locality between Barton Creek and Salt Fork of Red River. Wishing to extend the explorations further to the north and east the party continued on north about five miles to the head of Petrified Cañon, camping there a few days, then turning east traveled down Whitefish Creek about twenty-five miles to Skillet Creek, making another camp at this place. At the head of Petrified Cañon were found the skulls and parts of skeletons of twelve three-toed horses. Unfortunately, however, the bones were badly crushed and broken and covered with a hard limestone concretion which is very difficult to remove without injury to the fossil.

On the divide east of Skillet Creek the writer obtained three important specimens, a skull and lower jaws of a Mastodon (No. 10673, American Museum Collection) of the *M. productus* type, both fore feet complete of a second individual (No. 10672, American Museum Collection) of the same species, and a skull with a few skeleton bones of the big dog *Dinocyon*

gidleyi (No. 10671, American Museum Collection) subsequently described by Dr. W. D. Matthew.[1]

The creeks have cut deeply into the underlying strata of the Triassic in this locality, and erosion has entirely obliterated the Miocene deposits from many of the divides.

The deposits that remain in this vicinity differ greatly in character from the exposures along Barton Creek and to the west. They represent much more the appearance of the underlying red beds of the Triassic, from which the materials composing them are apparently derived.

Finishing the work at this locality the party made a second visit to the Blanco beds at Mount Blanco. Except for a few days of fruitless search in the vicinity of the mouth of Tule Cañon, the remainder of the time was occupied in a second careful examination of the deposits at this place and in exploring Blanco Cañon to its mouth. The most important specimens found on this second trip to Mount Blanco were the *Glyptodon* specimen referred to above and a new species of *Platygonus*, since described by the writer[2] (*Platygonus texanus*, No. 10702, American Museum Collection).

Returning to Clarendon, practically by the route taken the year before in going from Clarendon to Mount Blanco, the three years' work in northwestern Texas was at an end.

Geological Notes.

Professor W. F. Cummins, in the very complete and interesting reports of his explorations in northwestern Texas,[3] has so fully, and, for the most part, accurately described the general geological character and stratigraphy of the Staked Plains, that an attempt at any such extensive and detailed description here would be an unnecessary repetition of much of Cummins's work. Cope [4] has given detailed descriptions of the fossils, taken from various localities, apparently verifying Cummins's determination of the various beds. It is, therefore, the inten-

[1] Bull. Am. Mus. Nat. Hist., Vol. XVI, 1902, pp. 129–136.
[2] Bull. Am. Mus. Nat. Hist., Vol. XIX, 1903, p. 478.
[3] Geol. Surv. Texas, 3rd Ann. Rep., 1891 (1892), pp. 129–200; 4th Ann. Rep. 1892 (1893), pp. 179–238.
[4] Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), pp. 11–87. Proc. Acad. Nat. Sci. Phila., Vol. XLV, 1894 pp. 63–68.

tion of the writer to discuss, in some detail, only the more important localities with the purpose of correcting some obvious errors made by Cummins, both in the distribution and correlation of these beds, and to present briefly some of the writer's observations and conclusions which are at variance with those of both Cope and Cummins. These conclusions are briefly as follows:

(1) The fossil-bearing formations are fluviatile, not lacustrine, in origin.

(2) The Blanco has a limited distribution.

(3) The Goodnight (Paloduro) Beds are not a valid division.

(4) The principal deposits forming the Staked Plains are of the Miocene epoch but older than the Loup Fork stage.

(5) The fossil-bearing beds in the locality north of Clarendon and at Mulberry Cañon correspond in age with the Loup Fork formation, as shown by the fossils.

Pleistocene.

Rock Creek Beds.[1] = *Sheridan* (*Equus*) *Beds.*

The Sheridan or Equus division of the Pleistocene beds, as reported by Cummins, are extensively exposed, especially along the south side of Tule Cañon and at the head and on both sides of Rock Creek, a small tributary emptying into Tule Cañon from the south.

Cummins's section of Tule Cañon, taken near the head, is as follows:

6.	Fine white sand	25 feet
5.	Coarse sand, with pebbles	20 "
4.	Bluish clay	15 "
3.	Coarse sand	30 "
2.	Reddish clay	60 "
1.	Triassic sandstone	20 "

The upper four strata of this section (Nos. 3–6) belong to the Pleistocene age. But the section is representative of these beds only in a general way. Other sections taken at different

[1] Local name proposed by the writer

Pleistocene Exposures, at Head of Rock Creek, Swisher Co., Texas.

In the middle foreground is seen the quarry from which were taken six partial skeletons of *Equus scotti*.

points show great variations in details of character and in the relative thickness of the different strata. No. 1 belongs to the Triassic, which apparently underlies the whole of the Staked Plains. No. 2 of the section, designated by Cummins as "Reddish clay," is probably of Miocene age, as will be shown later. Unfortunately no characteristic fossil remains have been found in this stratum to fix definitely its geological position. However, it is older than the Sheridan beds, as are also the strata which bound them on the north and south. The Sheridan beds are unconformable with those of this older formation and apparently mark the course of an ancient stream which, after scooping out a channel or narrow valley in the older formation, refilled it again in Pleistocene times.

Fig. 1, page 625, is a diagrammatic cross-section across Tule Cañon near its head.

There is nothing in the character of the deposits to indicate beds of lake formation. On the contrary, the distribution of the beds, which are nowhere very wide but extend several miles east to the edge of the Plains, indicates, rather, an alluvial origin. The sharp cross-bedding of sand, gravel, and clay, which the writer observed at certain points in the formation, and the peculiar distribution of the coarser gravels, all indicate the depositions of a river or smaller stream rather than those of a lake. A further indication of an alluvial derivation of these beds is that the fauna represented consists wholly of land forms, and some of the bones show weather checking. The wind, carrying large quantities of fine sand and dust from the surrounding plains, may also have played a very important part in forming these deposits.

Following is a list of species from the beds at Tule Cañon, as given by Cope [1]:

TESTUDINATA.

Testudo hexagonata Cope,
" *laticaudata* Cope.

EDENTATA.

Mylodon ? sodalis Cope.

PROBOSCIDIA.

Elephas primigenius Blum.[2]

DIPLARTHRA.

Equus excelsus Leidy,
" *semiplicatus* Cope,
" *tau* Owen,
" *major* Dekay,[3]
Holomeniscus sulcatus Cope,
" *macrocephalus* Cope.

[1] Rep. Geol. Surv. Texas, 1892 (1893), p. 87.
[2] *Elephas primigenius*, probably *E. imperator*.
[3] *Equus major* = *E. complicatus*

The following additional species were taken from these beds by the American Museum party:

Elephas imperator,	*Platygonus* sp. ind.
Equus scotti,	Large carnivore, gen. et sp. ind.

Pliocene.

Blanco Beds.

The Blanco beds have been correctly referred to the Pliocene age, as is shown by the peculiar fauna they contain; Cummins has, however, given them a much wider distribution than is evident from a close study of the formations in that region. He says of these beds[1]: "This formation constitutes the eastern scarp of the Staked Plains from the Double Mountain Fork of the Brazos River on the south to Paloduro Canyon on the north."

Cope also reported exposures of these beds northeast of Miami, Roberts County, Texas, more than one hundred and fifty miles to the north of Mount Blanco. His identification was founded on some fossil horse teeth which he referred to *Equus cumminsii* Cope. This species, as has been shown by the writer in a former paper,[2] is not referable to the genus *Equus*, and is indistinguishable at present from some species of the Loup Fork *Protohippus*, hence the correctness of Cope's identification of Blanco beds at Miami is, at least, doubtful.

Cummins was probably led to error by including in his section of the Blanco beds strata properly belonging to beds of an older age.

Cummins's sections of the Blanco beds, taken at two different localities, are as follows[3]:

At Mount Blanco.

12.	Soil	8 feet
11.	Hard limestone	2 "
10.	Sandstone	3 "
9.	Stalactitic limestone	4 "
8.	Calcareous sandstone	4 "
7.	White sandy clay	30 "
6.	White diatomaceous earth	4 "
5.	Packsand	20 "

[1] Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), p. 201.
[2] Bull. Am. Mus. Nat. Hist., Vol. XIV, pp. 126, 127.
[3] Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), pp. 200, 201.

Blanco Beds.

One half-mile southwest of Mount Blanco.

4. White diatomaceous earth	8	feet
3. Green sandy clay	30	"
2. Red clay	2	"
1. Reddish clay	30	"

Three miles north of the old town of Docum, in Dickens County:

5. White sandy clay	6	feet
4. White diatomaceous earth	3	"
3. Purple clay	3	"
2. White diatomaceous earth	4	"
1. Reddish sandy clay	150	"

These sections are valuable only in giving the approximate thickness and general character of the deposits. No. 1, of both sections, is wrongly included in the Blanco series, as are also Nos. 9, 10 and 11 of the section taken near Mount Blanco. These strata belong probably to the Miocene age and are apparently continuous with the beds they so much resemble at Tule Cañon and other portions of the Staked Plains.

A complete section of this older formation is represented by Cummins's section taken "one fourth of a mile northwest of H. C. Smith's ranch and one mile north of Mount Blanco":

3. Limestone	2	feet
2. Stalactitic limestone	10	"
1. Red clay (same as No. 1 of previous section) [1]	30	"

The diagrammatic section, Fig. 2, page 626, taken by the writer across Blanco Cañon and through the Blanco beds, shows both of Cummins's sections taken near Mount Blanco and illustrates their relations to each other.

It is thus seen that the Blanco beds, at Mount Blanco, like the Rock Creek beds, apparently occupy a comparatively narrow valley or basin formed for their deposition by ancient erosion of the older beds. Like the Rock Creek beds also they extend a long distance in one direction, being traceable south-eastward for fifteen or twenty miles to the edge of the Plains. Though the deposits differ in character from those of the Rock Creek beds and the fauna indicates an earlier age, here, as at Tule Canoñ, there is a total absence of any proof of a lake origin for these beds and many evidences of river or stream deposition.

[1] Cummins refers to the section taken near Mount Blanco and given above.

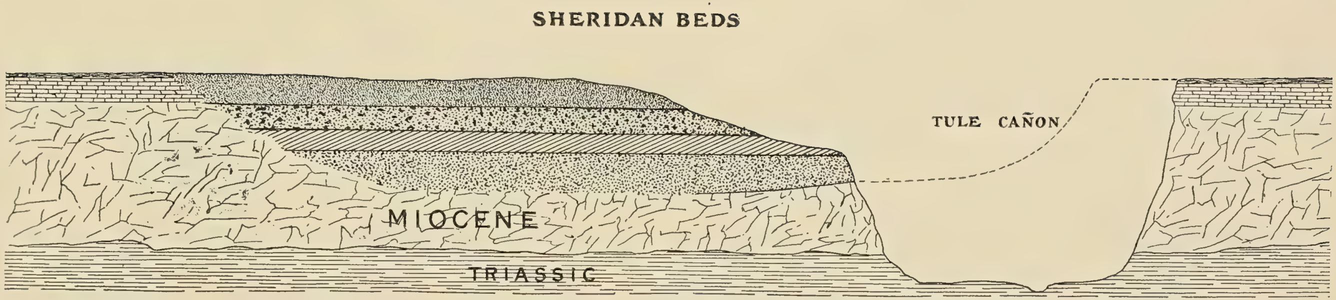


Fig. 1. Diagrammatic section across Tule Cañon near its head, showing position of Rock Creek (Sheridan) beds and underlying strata. Vertical scale about 1 in. to 150 ft.; horizontal scale about 3 in. to 1 mile.

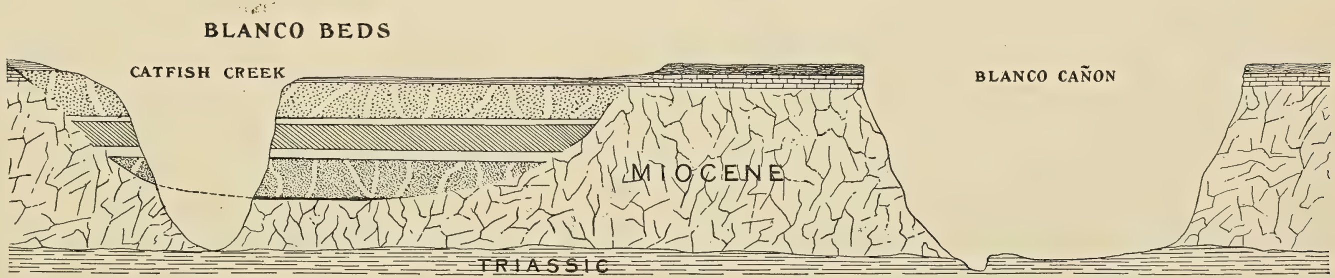


Fig. 2. Diagrammatic section across Blanco Cañon at Mount Blanco, showing position of Blanco beds and underlying strata. Vertical scale about 1 in. to 150 ft.; horizontal scale about 3 in. to 1 mile.

The occasional beds of diatomaceous earth are easily accounted for by supposing that there were in this ancient valley occasional ponds filled with clear water, enduring for various periods of time, partially or totally isolated from the stream that ran through the valley, such as exist at the present time in the West, especially in the Sand-hills country of northern Nebraska and southern South Dakota. The diatomaceous deposits are for the most part quite impure and contain great quantities of remains of rushes and pond grasses, indicating that these ponds were never of any great depth and probably occasionally received an overflow from the stream in times of freshet.

Following is the list of species, as reported and determined by Cope from the Blanco beds [1] and also as reported and determined by the American Museum Expeditions:

Cope.

TESTUDINATA.

Testudo turgida Cope,
" *pertenuis* Cope.

AVES.

Creccoides osbornii Schuf.

EDENTATA.

Megalonyx leptostoma Cope.

CARNIVORA.

Canimartes cumminsii Cope,
Borophagus diversidens Cope,
Felis hillanus Cope.

PROBOSCIDIA.

Tetrabelodon shepardii Leidy,
Dibelodon humboldtii Cuvier,
" *tropicus* Cope,
" *præcursor* Cope.

DIPLARTHRA.

Equus simplicidens Cope,[2]
" *cumminsii* Cope,[2]
" *minutus* Cope,[2]
Platygonus bicalcaratus Cope,
Pliauchœnia spatula Cope.

Total number of species, 16.

American Museum.

TESTUDINATA.

Testudo campester.

EDENTATA.

Glyptotherium texanum,
Megalonyx sp.,
Mylodon sp.

CARNIVORA.

Amphicyon (?Borophagus).

PROBOSCIDIA.

Dibelodon mirificus,
" *tropicus.*

PERISSODACTYLA.

Neohipparion sp.,
Pliohippus simplicidens.

ARTIODACTYLA.

Platygonus bicalcaratus,
" *texanus*,
Pliauchœnia spatula,
" sp.

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[1] Rep. Geol. Surv. Texas, 1893, p. 73.

[2] *Equus simplicidens* = *Pliohippus simplicidens; Equus cumminsii* = *Protohippus* sp.?, and *Equus minutus* = *Protohippus* sp.? See Bull. Am. Mus. Nat. Hist., Vol. XIV, pp. 123–128 and p. 140.

Miocene.

(?) *Goodnight* (*Paloduro*) *Beds.*

In 1893 Cummins proposed a new horizon, the Goodnight beds, placing it, in time, between the Loup Fork and Blanco divisions. In thus placing these beds he says: "I do this on both stratigraphic and palæontologic grounds. In making a stratigraphic section of the country, I found that the Goodnight fossil beds were above the conglomerate bed of the Loup Fork section made at Clarendon, the Clarendon beds being near the base of the Tertiary and below the conglomerate, while the beds at Goodnight were nearly at the top of the plains."

Following are Cummins's sections taken at the typical locality on opposite sides of Mulberry Cañon near its mouth:

North Side.

1.	White sandy clay, concretionary	60 feet
2.	Sandy clay	40 "
3.	Reddish sandy clay	25 "
4.	Conglomerate, cross-bedded	20 "
5.	Red clay, to the base	80 "
		225 feet

South Side, about one mile from the preceding section.

1.	Concretionary yellow limestone	4 feet
2.	Yellowish clay, with small concretions	12 "
3.	Concretionary limestone	3 "
4.	Yellowish sandy clay	40 "
5.	Hard stalactite limestone, breaking into conchoidal fracture	3 "
6.	Yellowish sandy clay, with small concretions, less concretionary at base	80 "
7.	Bright red clay	40 "
8.	Soft dark red sandstone	20 "
9.	Soft limestone	4 "
10.	Red clay, with white spots	20 "
		226 feet

A careful study of this region has compelled the writer to disagree with Mr. Cummins both as to the correctness of his

observations and in his interpretation of the strata in this locality. The writer could find no warrant for making any separation of the beds at Mulberry Cañon, either on stratigraphic or palæontologic grounds.

Briefly, Cummins's stratigraphic grounds for separating the Goodnight beds from the Loup Fork division are as follows: (1) That the Loup Fork beds in the vicinity of Clarendon were overlaid by the heavy cross-bedded conglomerate layer which underlies the upper series of strata at Mulberry Cañon. (2) That there is a marked difference in his two sections taken on opposite sides of Mulberry Cañon. He says of these sections: "It will be apparent upon examination of these two sections that there is a marked difference between them. The heavy bed of conglomerate on the north side of the canyon, No. 4 of the section, does not occur on the south side, nor was there any gravel on that side to show that the conglomerate bed had ever been there."

This statement is incorrect, for the writer found an abundance of gravel on both sides of the cañon and had no trouble in tracing the conglomerate layer (No. 4 of Cummins's section) across to the south side of the cañon where it is exposed in two localities, showing a maximum thickness of at least fifteen feet. This bed of conglomerate and sand is nowhere of great width, hence it does not appear in every section on either side of the cañon. The writer also found this coarse conglomerate bed appearing again in the Clarendon locality, resting directly on the eroded surface of the Triassic and *underlaying* the Miocene beds, but not overlaying them, as reported by Cummins. There are scattered patches of loose gravel partially covering the Miocene deposits in the vicinity, but it is superficially distributed and nowhere can be said to be in its original bed of deposition. It was probably this frequent occurrence of loose gravel which led Cummins to believe that the conglomerate bed had overlaid the Miocene in this locality.

Cummins's two sections taken at Mulberry Cañon are misleading, for no two sections, even though taken on the same side of the cañon, agree in detail. There is, therefore, no such real difference in the two sides of the cañon as these sections

apparently show. The main divisions of either section are traceable around the head of the cañon and are continuous with corresponding strata of similar character on the opposite side.

From the foregoing facts it seems evident that Cummins's separation of the Goodnight beds on stratigraphic grounds is scarcely admissible.

Cummins's palæontologic grounds for the separation of these beds is based on Cope's determination of the small collection of fragmentary fossils taken from the vicinity of Mulberry Cañon on the south side.

Cope's determination of these fossils is as follows [1]:

Aphelops sp.,
Protohippus lenticularis Cope,
Protohippus sp.,
" *? perditis* Leidy,
Hippidium interpolatum Cope,
" *? spectans* Cope,
Equus eurystylus Cope,
" *? simplicidens* Cope.

In referring to this list Cope [2] stated that two of these genera are characteristic of the Loup Fork beds, but are not known to extend higher; that *Equus*, on the contrary, had never been found in the Loup Fork formation; and that *Hippidium* was of uncertain horizon. Of the species Cope said "the three which are identifiable are new to science."

As shown by the writer in a former paper [3] *E. simplicidens* Cope and *E. eurystylus* Cope can not be referred to the genus *Equus*, but on the contrary are distinctly Miocene in character and only referable to Miocene genera. *Hippidium* is probably an exclusively South American genus, and the species referred to it by Cope are probably referable to the genus *Protohippus*. The three species from the Mulberry Cañon locality which Cope considered identifiable are as follows: *Protohippus lenticularis* Cope, *Hippidium interpolatum* Cope, and *Equus eurystylus* Cope.

The first of these species is, perhaps, authentic, but it is referable to the genus *Neohipparion* [4] and not to *Protohippus*.

[1] Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), p. 45.
[2] Geol. Surv. Texas, 4th Ann. Rep., 1899 (1892), p. 45.
[3] Bull. Am. Mus. Nat. Hist., Vol. XIV, 1901, pp. 123–126.
[4] The genus *Hipparion* was founded on an European type, though many American species have since been referred to it. The writer, however, has separated generically the American group from the Old World *Hipparion*, giving to the American group the name *Neohipparion*. (Bull. Am. Mus. Nat. Hist., Vol. XIX, p. 467.)

MULBERRY CAÑON

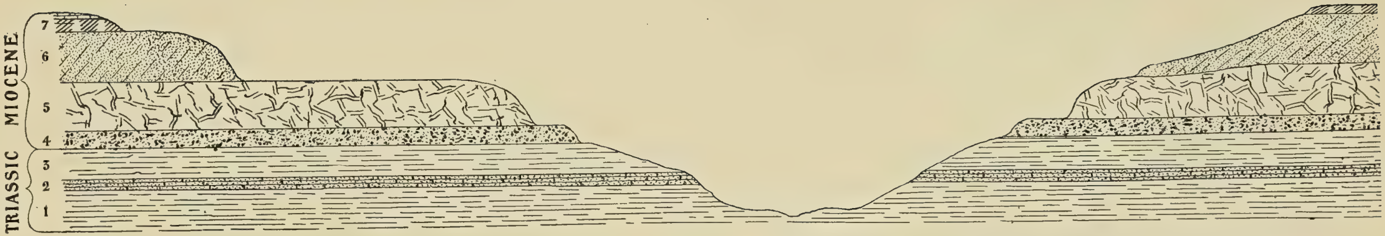


Fig. 3. Diagrammatic section across Mulberry Cañon near its mouth, showing position of Panhandle (Lower or Middle Miocene) beds and the underlying strata. Vertical scale about 1 in. to 250 ft.; horizontal scale about 2 in. to 1 mile.

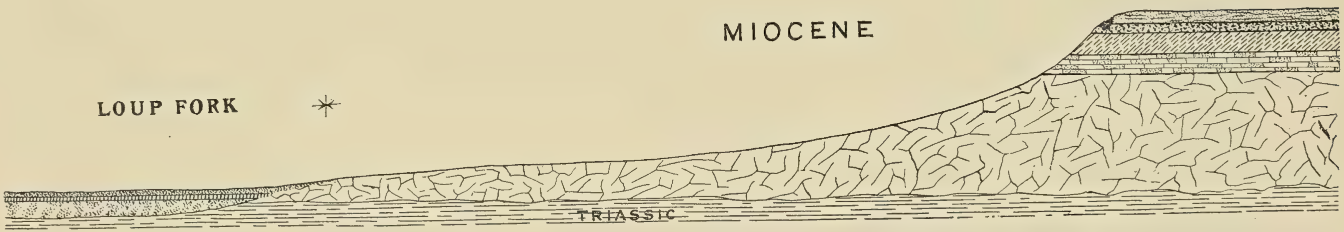


Fig. 4. Diagrammatic section of the Clarendon locality, showing position of Clarendon (Loup Fork) beds and Panhandle (Middle or Lower Miocene) beds, extending west to the top of the Staked Plains. Vertical scale about 1 in. to 300 ft.; horizontal scale about 1 in. to 1 mile.

The species does not indicate a later phase than the Upper Miocene, for the writer found, in the Clarendon locality, several specimens, including a skull with complete dentition, which are indistinguishable from *Protohippus lenticularis* Cope. The second species, as already mentioned, is indistinguishable from some species of *Protohippus*. The third species of this group, *Hipparion eurystylus* Cope, was founded on lower teeth and is not distinguishable from specimens found in the Clarendon locality. It is quite possible that Cope's type of this species represents the lower dentition of *Neohipparion lenticularis*, with which it corresponds in size.

Thus it will be seen that the palæontological evidence at hand not only fails to prove a new horizon for the so-called Goodnight beds, but, on the contrary, seems to prove conclusively that they are identical in age with the beds in the vicinity of Clarendon, which Cope recognized as Loup Fork (Upper Miocene) deposits.

There is little doubt, then, that there is no break at Mulberry Cañon, either in strata or fauna. Hence the Goodnight beds, as a new horizon, should be abandoned.

Upper Miocene.

Clarendon Beds.[1] *"Loup Fork" Stage.*

The deposits at the locality north of Clarendon belong undoubtedly to the Miocene epoch. The fauna indicates a close relationship with the Loup Fork formation.

This locality is east of the Staked Plains proper, but connected with them through long, low divides. The fossil-bearing strata do not, however, follow these divides back to the Plains, and is it impossible to say, owing to so much of the country in that direction being covered by recent deposits which are now more or less grass-covered, whether they extended any great distance to the westward or not. The

[1] Local name proposed by the writer. The name Loup Fork was first proposed as a formation name, and its subsequent extended use has given rise to so much confusion that it seems better not to employ it in the sense of a time division, but to limit its use to the formation occurring in the Loup River, Niobrara, and White River valleys for which it was originally used. The Clarendon beds are of approximately the same age as the Loup Fork beds, as judged by the known fauna, but cannot be regarded as a part of the same terrane, and they differ considerably in structure and composition

HEAD OF PETRIFIED CAÑON.

Showing excavation in Clarendon Beds from which were taken several skulls and partial skeletons of three-toed horses.

exposures, however, show an extensive distribution to the northeast.

Here again, as at Tule Cañon and Mount Blanco, the peculiar formation of the deposits indicates, though in a somewhat different manner, an alluvial origin. Though distributed over a wider area in every direction there are running through these beds several narrow channels of sandy clay. The main body of the beds consists for the most part of cross-bedded sands and sandstones intermixing more or less and cross-bedding with the clays. These channels all take a direction nearly east and west, or approximately the same as that of the streams draining the country at the present time. Some of them are traceable for long distances. It is in these peculiar beds of sandy clays that all the fossils of this region occur.

Cummins's section of the Clarendon locality is as follows:

1. Whitish sandy clay	20	feet
2. Sandy clay, with many rounded siliceous pebbles of different sizes	20	"
3. Yellowish sand	40	"
4. Indurated white sand	40	"
5. Yellow sandy clay, with the sand more or less predominating in places. In places the sand is hardened, while in others the clay is more or less concretionary	250	"
6. Alternating beds of bluish clay and white sand (Loup Fork)	30	"
	400	feet

Cummins has here placed the Loup Fork formation at the very bottom of this section of 400 feet of deposits. A careful study of this region, however, does not warrant such a disposition of this stratum. In reality this stratum (No. 6) belongs properly at the top of the above section, and the explanation is simple. Nowhere is bed No. 6 overlaid by any of the upper strata of the section; hence to obtain this section Cummins probably included the beds west to the top of the plains, and because No. 6 was at a lower level concluded that it ran under the beds to the west. This, however, is erroneous. The writer found several places where this fossilbearing stratum lies unconformably on the eroded surface of

beds resembling the lower portion of the beds to the west which Cummins identified as probably Goodnight beds. It seems certain, therefore, that the beds to the west are older than the fossil-bearing strata under discussion. This apparent inconsistency in level is due to the heavy erosion of the older beds before the Upper Miocene deposits were laid down.

The following species have been reported from the Clarendon locality:

Reported and Identified by Cope.	Obtained and Identified by the American Museum Expeditions.
Aphelops fossiger Cope,	*Mastodon productus*,
Protohippus perditis Leidy,	" sp.
" *parvulus* Marsh,	*Dinocyon gidleyi*,
" *fossulatus* Cope (sp. nov.),	" *mœandrinus*,
Protohippus mirabilis Leidy[1],	*Machœrodus* sp.,
" *placidus* Leidy,	*Teleoceras* sp.,
Hippotherium [2] *affine* Leidy,	*Hipparion* [3] *lenticularis*,
" *occidentale* Leidy,	" *occidentalis*,
Procamelus robustus Leidy,	" sp.,
" *gracilis* Leidy,	*Protohippus perditis ?*
" *leptognathus* Cope (sp. nov.),	" sp.,
Blastomeryx gemmifer Cope,	*Pliohippus ?* sp. nov.
Tetrabelodon serridens ? Cope.	*Procamelus* sp.,
	Pliauchœnia sp.

Middle or Lower Miocene.

Panhandle Beds.[4]

As to the age of these older beds it is difficult to say, owing to the present lack of palæontologic evidence, just where they should be placed. It is probable, however, that they are Lower or Middle Miocene.

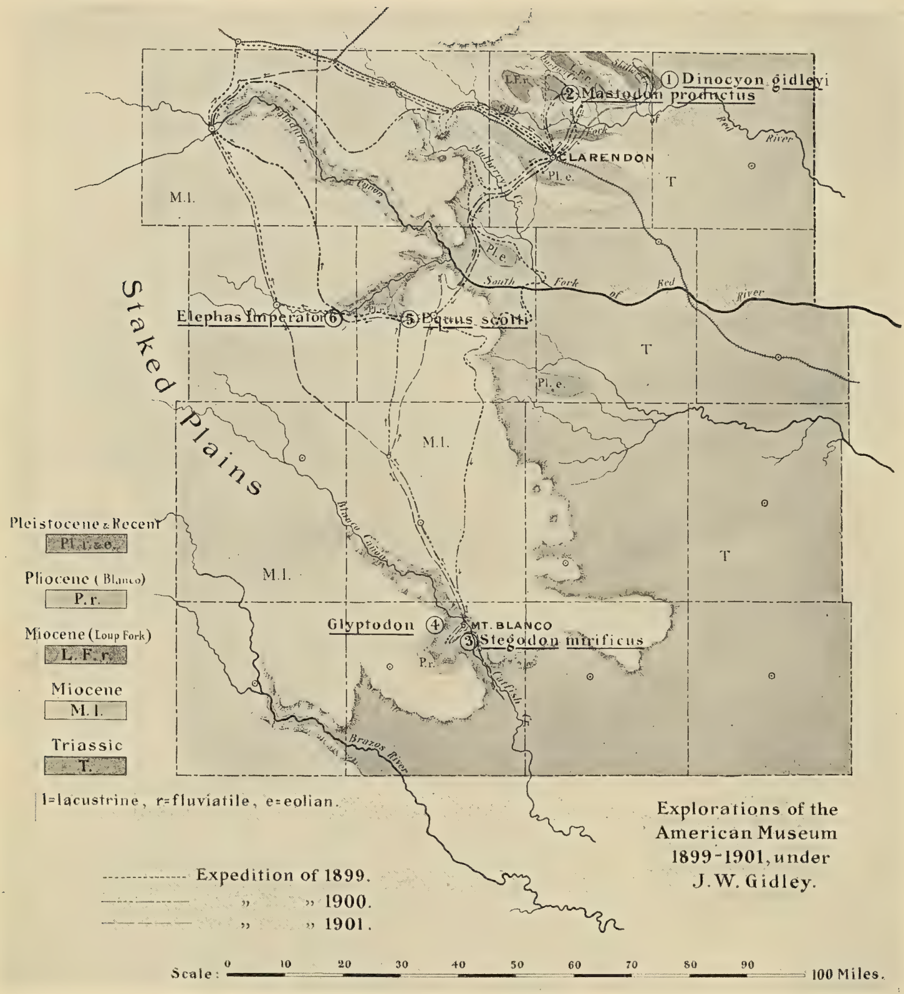
Some lower teeth of *Merycochœrus* and a lower tooth of *Procamelus* taken from these beds by the writer prove them to be not older than the Lower Miocene.

Though differing somewhat in detail in the different localities, these older beds in the vicinity of Clarendon, at Mulberry Cañon, at Mount Blanco, and at Tule Cañon and Rock

[1] *Protohippus mirabilis* = *Merychippus mirabilis.*
[2] *Hippotherium* = *Neohipparion.*
[3] *Hipparion* = *Neohipparion.*
[4] *Local name proposed by the writer.*

MAP OF TEXAS.

Showing area of Explorations.



Pleistocene = Rock Creek Beds.
Pliocene = Blanco Beds.
Miocene (Loup Fork) = Clarendon Beds.
Miocene = Panhandle Beds.

Creek are evidently of the same age. They closely resemble each other in a general way, and the formations are traceable from one locality to another around the irregular escarpment of the Plains. Numerous wells dotting the Staked Plains show everywhere the existence of these beds. They are of nearly uniform thickness, and form practically the whole area of the Staked Plains.

Summary.

Following is a summary of the conclusions reached by the writer from this study of the formations of northwestern Texas:

(1) There has been no great disturbance or change of level in the region of the Staked Plains since the close of the Triassic, hence the strata of the Triassic which underlie this whole region are for the most part nearly horizontal, and the country at the beginning of the Miocene was comparatively level.

(2) The Panhandle (Lower or Middle Miocene) beds were comparatively evenly distributed over the vast area now occupied by the Staked Plains and in addition extended westward to the Rocky Mountains in New Mexico, and spread out to the eastward over a much greater territory than they now occupy. These deposits seem to be, at least partially, lacustrine in origin.

(3) All the formations of the Staked Plains that are of more recent date than the Lower or Middle Miocene are represented by comparatively small areas, and are fluviatile, or æolian and fluviatile, in origin. These later depositions are represented by the Clarendon beds in the vicinity of Clarendon, the Blanco Beds at Mount Blanco, and the Rock Creek beds at Tule Cañon and Rock Creek.

Article XXVII. — A NEW KATYDID FROM FLORIDA.

By William Beutenmüller.

Cyrtophyllus floridensis, sp. nov.

Color. — Head and thorax light gray, with a faint tinge of green. Wing-cases green-gray. Legs greenish, basal half of femora pinkish. Head large, stout; eyes hemispherical, rather small. Vertex with a short spine, rounded at the tip, grooved on top. Antennæ twice as long as the body. Pronotum longer than broad on top, with two transverse furrows; lateral carina rounded to the second transverse furrow, thence rather sharply defined to the hind edge; lateral lobes a little narrower at the lower part than at upper; anterior angle acutely rounded; hind angle well rounded. Wings concave. Wing-covers longer than the hind wings, almost three times as long as broad, and almost of equal width; apex rounded. Legs very long, spinulate. Subanal plate very long, curved upwards, grooved above and below, furcate at the tip. Abdomen with a prominent spine on top of the second segment. Stridulating organs similar to those of *Cyrtophyllus perspicillatus.*

Measurements. — Length of body 43 mm. Length of wing-covers, 37 mm.; width, 13 mm. Length of pronotum on top, 8 mm. Length of anterior femora, 17 mm.; middle femora, 15 mm.; posterior femora, 28 mm. Length of anterior tibiæ, 15 mm.; middle tibiæ, 14 mm.; posterior tibiæ, 30 mm.

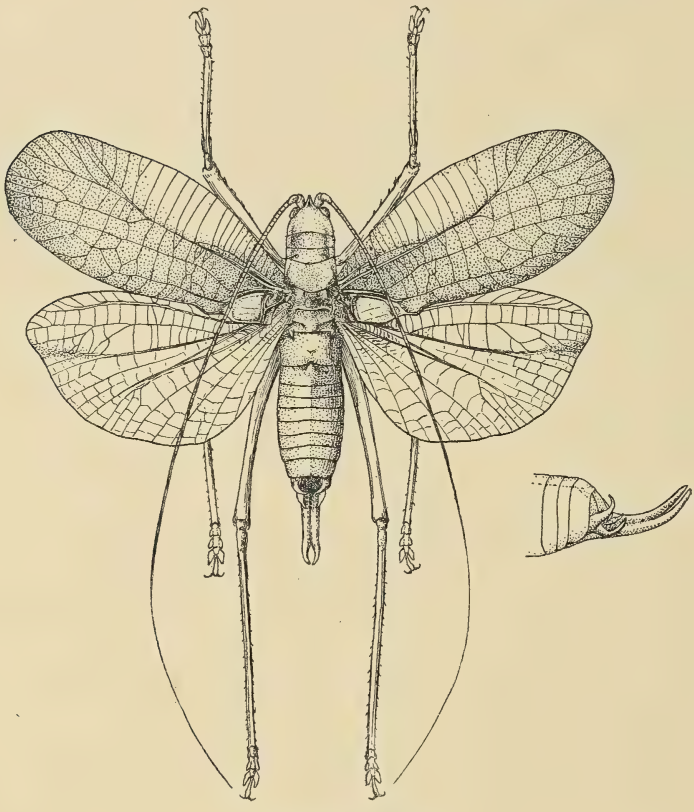
Habitat. — Indian River (opposite Grant), Florida.

Described from a single male taken in July. Type, Coll. Am. Mus. Nat. Hist.

This species is arboreal in habit, living in the tops of the live oak. It differs from the northern Katydid (*Cyrtophyllus perspicillatus*) in being larger, differently colored, and with the legs considerably longer. The wing-cases are also narrower, the thorax longer and the subanal plate curved upward. It is possible that a new genus may have to be erected for the species, or it is even possible that it may be a West Indian species already described. At any rate it is different from our northern species, to which it is closely allied, especially in having the wings concave like *Cyrtophyllus perspicillatus.* The stridulation is also different from that of this species, being

a continuous *kerr-kerr-kerr-kerr*, with about one second interval of rest.

The species is not rare on the narrow strip of land dividing



Cyrtophyllus floridensis.

the mainland from the ocean on the coast of Florida. It is, however, exceedingly difficult to obtain, owing to its habitat in the dense tree-tops.

Article XXVIII. — EXTRAORDINARY FEMALES IN THREE SPECIES OF FORMICA, WITH REMARKS ON MUTATION IN THE FORMICIDÆ.

By William Morton Wheeler.

The three species of *Formica* described in the following paper were all taken within a radius of thirty miles of Colorado Springs, Colorado, during the past summer. They agree in presenting certain very unusual characters in the females, although the corresponding workers and males deviate but little from the ordinary species of *Formica*. Even a superficial study of the workers shows that they are all to be assigned to the *rufa* group, and were this sexual phase alone known, one would be tempted to regard them merely as subspecies or varieties of *F. rufa*. Fortunately we are not bound still further to complicate this well-known circumpolar species by including under it the three Colorado forms, since the females and, to some extent also, the workers and males display characters of undoubted specific value.

The first species, *F. ciliata* Mayr, has hitherto been known only from isolated female specimens.[1] Emery, in his revision of the North American *Formica*,[2] erroneously regarded it as perhaps belonging to the *pallide-fulva* group. It departs from all known species of the genus in its singular pilosity and, to a lesser degree, in the yellow color of the whole body. The female of the second species, *F. oreas* n. sp., is remarkable in coloration and to some extent also in pilosity, especially in that of the antennal scapes. In coloration it resembles the female of *ciliata* as well as that of *F. dakotensis* Emery. The third species, *F. microgyna* n. sp., is remarkable on account of the diminutive size of the females, which are actually smaller than the largest workers, a condition quite unknown among the normal females of any other species of *Formica*.

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[1] Mayr, G. Die Formiciden der Vereinigten Staaten von Nordamerika. Verh zool. bot. Ges. Wien, 1886, pp 419–464.

[2] Emery, C. Beiträge zur Kenntniss der nordamerikanischen Ameisenfauna. Zool. Jahrb., Abth. f. Syst., Bd. VII, 1893, pp. 633–682, Taf. 22

I subjoin descriptions of all three sexual forms of each of the three species, together with some ethological field notes. At the end of the paper I have added a few remarks on the significance of the aberrant female characters.

Formica ciliata *Mayr.*

Worker (fig. 1,—Length, 3–8 mm.

With the habitus of *Formica rufa* subsp. *obscuriventris* Mayr. Mandibles 8-toothed. Clypeus broadly rounded in front, hardly produced in the middle, strongly carinate its entire length. Head, excluding mandibles, fully as broad as long; occipital border slightly concave, especially in large individuals; posterior corners rounded; sides distinctly converging anteriorly, cheeks rather long. Joints 1–4 of antennal funiculus decidedly more slender and somewhat longer than joints 5–10. Thorax resembling that of *F. rufa;* mesoëpinotal constriction pronounced, basal surface of epinotum flattened, horizontal, forming a decided angle with the slightly concave declivity. Petiole in profile rather thick at the base, with a thin edge; its anterior surface distinctly convex, the posterior flattened; seen from behind, the scale is produced upwards in the middle in the form of a blunt point, sides rounded.

Mandibles finely and densely striated. Whole body opaque, except the frontal area and clypeus and, in the largest workers of some colonies, also the whole head, which are more or less shining. Head, thorax, petiole, and gaster very finely shagreened.

Hairs yellow, those on the clypeus and mandibles rather coarse, on the former projecting forward. Upper surface of head naked; lower surface with a few erect hairs. Thorax covered with erect hairs, except the mesonotum, mesopleuræ, and basal epinotal surface, which are naked. Petiole below and along edge of scale with a fringe of short hairs, also with a few hairs on its anterior and posterior surfaces. Gaster invested with short, rather dense grayish yellow pubescence in addition to numerous uniformly distributed, suberect, and subobtuse hairs, which are hardly longer on the terminal segments than elsewhere. Antennæ delicately and inconspicuously pubescent. Legs with sparse pubescence; coxæ and flexor surfaces of tibiæ and tarsi with prominent hairs.

In the largest workers the head, thorax, and petiole are rich yellowish red, the mandibles and clypeal sutures deeper red. Gaster brown anal segment, and often also the base of the first segment and the venter, yellow. Antennæ and legs reddish yellow, the funiculus toward the tip, the coxæ, femora, and often also the tibiæ, dark brown. The smallest workers usually have the posterior portion of the head, dorsal surface of thorax and of petiole clouded with black or dark brown.

In some small specimens the whole body excepting the mandibles and anterior portion of the head, is uniformly infuscated.

Female (Fig. 1, — Length, 6–8 mm. Mandibles 8-toothed. Clypeus with broadly rounded anterior border, not produced, indistinctly carinate. Antennæ rather slender. Head, excluding the mandibles, hardly longer than broad, decidedly narrower in front than

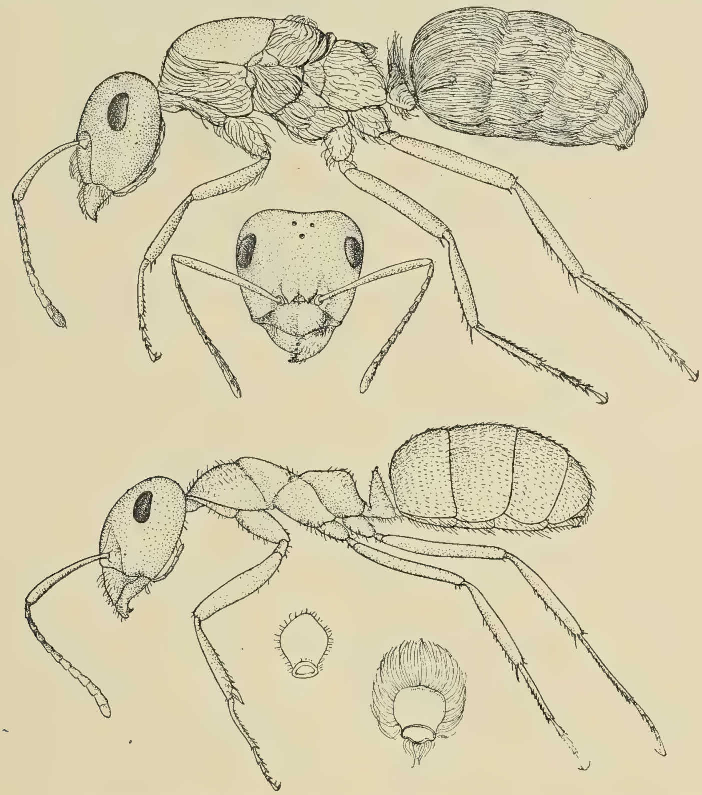

Fig. 1. *Formica ciliata* Mayr. Female (deälated) and worker in profile; head of worker (frontal view); petiole of worker and female from behind. This and the following figures are all drawn to the same scale.

behind, occipital border nearly straight. Thorax rather small, somewhat narrower than the head. Petiole broadly rounded above, scale not produced in the mid-dorsal line as in the worker; posterior and anterior surfaces as in the worker, edge sharp.

Mandibles subopaque, striato-punctate. Body and appendages smooth and shining, especially the head, mesonotum and scutellum, which are very glabrous.

Pilosity remarkable, consisting of very long, golden yellow hairs, which have a tendency to curl at their ends. These hairs are absent on the upper surface of the head, the mesonotum, and legs, excepting the coxæ. They are long and conspicuous on the mandibles and clypeus, on the latter scattered over the disc and also arranged in a row along the anterior border. Lower surface of head with appressed long hairs. Remainder of body, excepting the nude portions above mentioned, covered with long woolly hairs, which are very prominent on the petiole, around the edge of which they form a conspicuous fan (Fig. 1, *e*). On the gaster they are very long and abundant, appressed, overlapping, and curled at their extreme ends, so that this region of the body appears opaque, in marked contrast to the head and mesonotum. Antennæ and legs covered with delicate, inconspicuous pubescence, flexor surfaces of fore femora with flexuous hairs, corresponding surfaces of middle tibiæ each with a single row, hind tibiæ with two rows of stiff hairs.

Rich reddish yellow throughout; only the following regions being infuscated or blackened: terminal half of funiculus, metanotum and adjacent portion of scutellum and the alar insertions. Wings uniformly grayish hyaline; veins and apterostigma more yellowish gray, the latter not very conspicuous.

Male. — Length, 6.5–8 mm. Mandibles sharply pointed, edentulous. Head very short, very broad behind the eyes, very narrow in front, occipital border straight. Clypeus strongly carinate. Maxillary palpi 5-jointed. Thorax robust, broader than the head. Petiole thick, convex anteriorly, more flattened posteriorly, border very blunt, evenly rounded both in profile and when seen from behind. Gaster rather broad, with flattened dorsal surface. Genitalia of the usual size.

Whole surface of body and appendages opaque, the former finely shagreened; dorsal surface of gaster with a slight silky lustre.

Body, legs, and antennæ covered throughout with short grayish hairs and pubescence. Eyes hairy.

Deep black. Genitalia pale yellowish, tipped and bordered with black. Wings grayish hyaline, of a little deeper tint than in the female. Veins and apterostigma black.

Described from numerous females, males, and workers taken from several colonies during the latter half of July (13th to 28th). These colonies were all found in the Ute Pass about Manitou or between Manitou and Colorado City on sunny mountain slopes at an altitude of 7000–8000 feet. The nests resembled those of small colonies of *F. rufa*. Sometimes a colony occupied several small mound-nests close together and

consisting of vegetable débris collected by the ants. At other times the nests were under stones banked about their edges with débris (like the colonies of *F. rufa* subsp. *difficilis* in the New England hills). The largest nest was found July 17 near Red Rock Cañon opposite the Garden of the Gods. It was a débris mound built around the stem of an Opuntia, and measured 40 by 60 cm. in diameter and 5–10 cm. in height. In it were found hundreds of workers, dozens of females, and a few males. The pugnacious workers behaved like the workers of *F. rufa*.

Formica oreas, n. sp.

Worker (Fig. 2). — Length, 4.5–7 mm. With the habitus of *F. rufa* subsp. *obscuriventris* and very similar to the worker of *F. ciliata*, but differing in the following characters: When seen from behind, the petiole, though variable, is usually rounded above or even somewhat depressed in the middle. Some individuals, however, have a blunt median projection; in profile the anterior surface is distinctly convex, the posterior flattened or even somewhat concave, its edge rather sharp. Depth of mesoëpinotal constriction also variable, being considerable in some and not very conspicuous in others. In some individuals the basal and declivous surfaces of the epinotum form almost a right angle with each other.

Body opaque; mandibles, clypeus, frontal area, and front of head somewhat shining.

The pilosity also resembles that of the *ciliata* worker, but is more general, more abundant, and silvery white instead of yellow. Upper and lower surfaces of head, petiole, mesonotum, and mesopleuræ, as well as the remainder of the thorax, with numerous short, erect hairs. These hairs are conspicuously long on the ocellar region. Antennal scapes as well as the legs with prominent, suberect hairs. On the gaster the short, suberect hairs are less conspicuous than in *ciliata*, so that this region appears more uniformly grayish on account of the dense pubescence. Hairs on the terminal segments longer and more slender.

In color the following differences may be observed: legs, especially middle and hind pairs blacker, bases and tips of femora and of tibiæ red; fore coxæ much less infuscated than the posterior pairs. Gaster black, with clear reddish yellow anal segment. Smallest workers much less infuscated on the dorsum than the smallest *ciliata* workers. In some of these minims the vertex, pro- and mesonotum are each blotched with black; but in others the head and thorax are almost immaculate.

Female (Fig. 2). — Length, 7.5–9 mm. Robust, and with the stature of the typical *Formica* females. Mandibles 8-toothed. Cly-

peus convex, rounded in front, indistinctly carinate. Head, excluding the mandibles, as broad as long, sides converging anteriorly, posterior corners prominent, rounded, occipital border nearly straight. Thorax nearly as broad as the head, robust. Petiole broad, compressed anteroposteriorly; in profile faintly convex in front, flattened

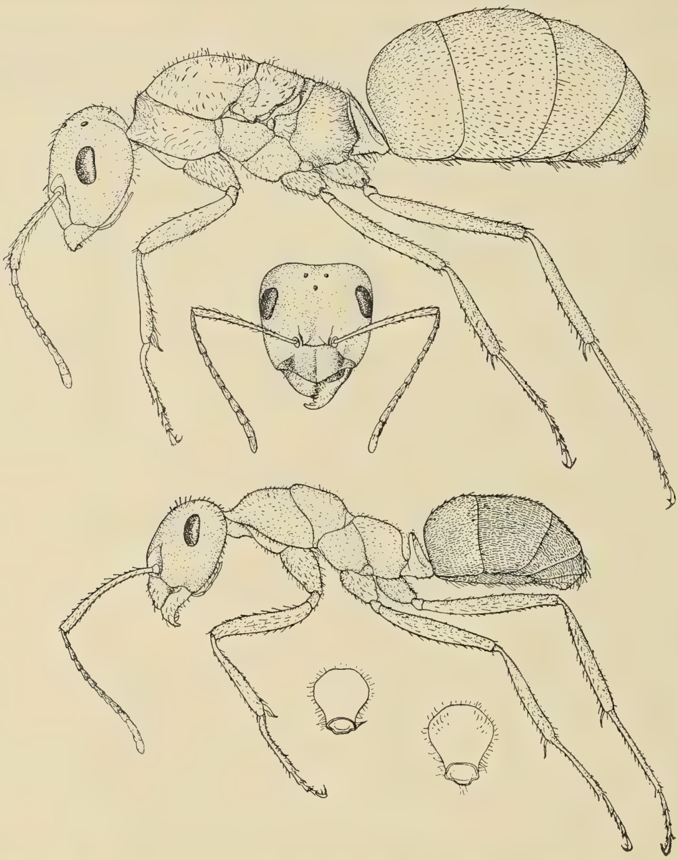

Fig. 2. *Formica oreas* n. sp. Female (deälated) and worker in profile; head of worker (frontal view); petiole of worker and female from behind.

behind; seen from behind, the rather sharp border is depressed and horizontal in the middle and trancated on the sides. Gaster and legs of the usual conformation.

Mandibles striatopunctate, subopaque. Body and appendages smooth and shining, especially the upper surface of the head, mesonotum, and scutellum, which are highly glabrous.

Entire insect covered with delicate erect or suberect silvery white hairs, which fail to conceal the ground color as in *ciliata.* These hairs are conspicuous on the antennal scapes, legs, and gaster, less abundant on the front of the head and on the mesonotum, at least in some specimens.

Color rich yellowish red; only the following regions infuscated or black: mandibular teeth, anterolateral borders of clypeus, thoracic sutures, alar insertions, metanotum, adjacent border of scutellum, posterior border of each gastric segment, palpi, articulations of legs, and terminal half of funiculus. Wings uniformly gray, veins and apterostigma sordid yellow.

Male. — Length, 7 mm. Mandibles with a short, acute terminal and three distinct basal teeth. Maxillary palpi 5-jointed, slender. Head small, cheeks rather concave, postocular region less prominent than in the male *ciliata.* Thorax robust, through the alar insertions decidedly broader than the head. Petiole thick at base, but ending above suddenly in a very thin edge in the middle. Seen from behind, the border is horizontal and depressed in the middle, obliquely and somewhat concavely truncated on either side. Gaster compressed dorsoventrally. Genitalia moderately large.

Body opaque, finely shagreened. Mesonotum, scutellum, and gaster above slightly lustrous.

Whole insect, including the appendages, covered with rather dense gray hairs. These are longest and suberect on the head, thorax, and petiole, more reclinate on the gaster, short and subappressed on the antennæ and legs. Eyes distinctly hairy. Gaster, moreover, delicately gray pubescent.

Deep black; genitalia, tips of trochanters, knees, basal portions of first and second tarsal joints, reddish yellow. Wings like those of the female, except that the apterostigma is more deeply infuscated.

Described from many workers and females and a single male taken from two colonies in the Ute Pass, Colorado. One of these colonies, containing the sexual forms, was found July 26 at Woodland Park (8500 ft.), well up in the Pass. The colony occupied several nests in an open, sunny place under some large stones, the edges of which were banked with vegetable débris collected by the ants. The other colony, containing workers only, was found near Manitou at a lower altitude, under otherwise similar conditions.

Formica microgyna, n. sp.

Worker (Fig. 3). — Length, 3.5–6.5 mm. With the habitus of a small *Formica rufa.* Mandibles 8-toothed. Clypeus rounded in

front, not produced in the middle, carinate its entire length and with uneven surface. Maxillary palpi rather long. Head, excluding the mandibles, somewhat longer than broad even in the largest workers. Cheeks long, subparallel, occipital border not excised; antennæ like those of the preceding species and *F. rufa.* Mesoëpinotal constriction very distinct, epinotum more rounded than in either of the preceding species, its dorsal and declivous surfaces of about equal length, the former convex, the latter slightly concave in profile. Petiole narrow and thick, with a sharp edge, convex anterior and flattened posterior face; seen from behind, the edge varies from evenly rounded or even somewhat produced upward in the middorsal line to subdepressed or concave. Gaster and legs as usual.

Body, including mandibles and clypeus, opaque, legs faintly lustrous. Frontal area shining.

Entire insect, including appendages, covered with microscopic gray pubescence, densest and most distinct on the gaster. Hairs pale yellow, erect, and, except on the mandibles, distinctly clavate with obtuse tips. These hairs are placed rather far apart on the clypeus, on the front of the head, where they form four longitudinal rows as far back as the ocelli, on the thoracic dorsum, coxæ, border of petiole, and surface of the gaster. On the last they are particularly conspicuous on account of their equidistant arrangement and contrasting color. They are readily rubbed off. A few of these hairs are occasionally present on the lower surface of the head, but entirely absent in most specimens. Anterior border of scape with a row of delicate, suberect, tapering hairs and a row of similar hairs on the flexor surface of each tibia.

Head, thorax, and petiole deep yellowish red, mandibles and clypeus somewhat darker. In small workers, the front, vertex, thoracic dorsum, and petiole are spotted with black. Gaster black, only the anal region yellowish. In the largest workers the legs are red throughout, in intermediates the femora and tibiæ are brownish, in the smallest workers the infuscation extends also to the coxæ. Antennæ red, funiculus more or less infuscated toward the tip.

Female (Fig. 3). — Length, 4–4.5 mm. Mandibles 8-toothed; clypeus and head resembling those of the worker; thorax distinctly narrower than the head. Petiole narrow, thick at the base, both its anterior and posterior surfaces alike convex, dorsal border rather sharp; seen from behind variable, in some specimens evenly rounded, in others somewhat produced upward in the middorsal line. Gaster and legs of the usual shape.

Body subopaque, very finely shagreened; gaster and anterior portion of head faintly shining. Mandibles striatopunctate. Frontal area shining.

Whole insect, including the antennæ and legs, covered with delicate white hairs, which are longer and more abundant than in the worker, and nowhere clavate or obtuse. These hairs are conspicuously long

and suberect on the frontal and lower surfaces of the head, on the thorax, petiolar border, gaster, antennal scapes, and legs. In addition to these hairs the body and appendages are invested with microscopic white pubescence.

Head, thorax, petiole, and legs dull, reddish yellow. Mandibular teeth, funiculi, a blotch covering the ocellar region, a large antero-

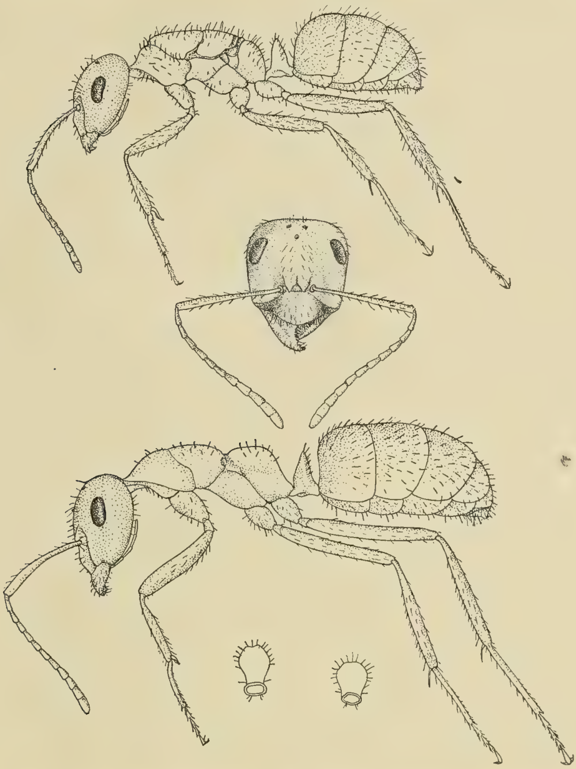

Fig. 3. *Formica microgyna* n. sp. Female (deälated) and worker in profile; head of worker (frontal view); petiole of worker and female from behind.

median mesonotal, two elongate parapsidal blotches, alar insertions, metanotum, and more or less of the adjacent portion of the scutellum, fuscous. In some specimens the clypeus, frontal region, coxæ, and pleuræ are infuscated. Gaster black, anal segment and more or less of the base of the first segment, brownish yellow. Wings whitish hyaline, veins and stigma brown, the latter conspicuous.

Male. — Length, 5–5.5 mm. Mandibles slender, edentulous,

pointed. Maxillary palpi 5-jointed. Head rather short, broad behind the eyes, narrow in the region of the cheeks. Eyes large and prominent. Clypeus distinctly carinate anteriorly, its border somewhat reflected. Antennæ slender. Thorax broader than the head, rather robust, mesonotum conspicuously flattened just in front of the scutellum. Petiole very thick with obtuse and broadly rounded upper surface. Genitalia rather slender.

Subopaque; frontal area, anteromedian suture of mesonotum, parapsidal furrows, paraptera and upper surface of gaster, smooth and shining. Mandibles coarsely punctate near the tips, finely striated toward the base.

Body and appendages clothed with microscopic grayish pubescence, which is sparse and visible only in certain lights. Hairs covering the body and appendages delicate, sparse, suberect, of an indistinct grayish color. Eyes naked.

Deep black; legs and genitalia dirty yellow; coxæ, femora, tibiæ, and terminal tarsal joints more or less infuscated. Wings like those of the female.

Described from many workers and females and a single male. Six colonies of this species were found in different localities about Manitou and Cheyenne Cañon, Colo. (July 10 to 30). In three of these I took the diminutive females in considerable numbers. They varied but little in size and were all normal in structure. When the nests were disturbed, they were as timid as the workers were pugnacious. The nests were all under single stones or clusters of stones, the edges of which were banked with vegetable débris collected by the workers. A single incipient colony, under a small stone in South Cheyenne Cañon, was found to contain about twenty workers, a few worker cocoons, and a gynandromorph, which had a female head, male gaster, and the thorax and petiole male on one side and female on the other.

I have also found the following distinct variety of the above species:

Formica microgyna var. **rasilis** var. nov.

All three sexual phases averaging somewhat larger than the typical form (worker: 4–6.5 mm.; female, 5–5.5 mm.; male, 6–6.5 mm.). The worker and female have the antennal scape, lower surface, and posterior corners of head, and the legs, excepting for the row of hairs on the flexor surfaces of the tibiæ, entirely naked. Hairs on the clypeus, thorax, and petiole much less numerous. Frontal area opaque.

In the female the black blotches on the head and thorax are indistinct or entirely lacking, even in mature specimens, and the hairs on the head, thorax, petiole, and gaster are thick, clavate, and obtuse, instead of tapering as in the female of the typical form. In the male the mandibles are decidedly broader than in *microgyna* s. str., and furnished with three distinct basal teeth. Paraptera opaque, legs more deeply infuscated. Suberect hairs on lower surface of head, and on legs sparse or entirely lacking. External genital valves broader and blunter at their tips.

This variety appears to be commoner and more widely distributed than the typical form and occurs in more populous colonies. These live under stones, and may occupy separate nests covering an area of a square meter or more. Between July 11 and August 21, I found, in all, thirteen of these colonies in the neighborhood of Manitou (Red Rock Cañon, Williams Cañon, Ute Pass), between Broadmoor and Cheyenne Cañon, and on Pike's Peak. The largest colony, found in Cheyenne Cañon July 20, contained many males and several dozen of the diminutive females. Some of the latter were deälated and in all probability were the mother queens of the colony. Three of the colonies deserve special mention: First, a colony taken at Woodland Park (8500 feet) July 26, contained only workers, which were clearly intermediate between the true *microgyna* and the var. *rasilis*, as the antennal scapes and legs were beset with a few suberect hairs. Second, a colony taken on Pike's Peak, August 4, at an altitude of 11,500 feet, very near timber-line, differed from the colonies taken at lower altitudes in the deep infuscation of the head and thorax even in the largest workers. Third, a colony taken at Broadmoor, August 8, was mixed with workers of a small variety of *Formica fusca*, near *subsericea*. The two species were living together in such perfect amity (synclerobiosis) that I at first mistook them for a colony of *F. sanguinea* with slaves.[1]

The anomalous character of the three Formica females above described, especially of *F. ciliata* and *microgyna*,

[1] Since this paper was sent to press I have received from Mr. R. V. Chamberlin numerous females and workers of *F. microgyna* var. *rasilis* collected near Salt Lake, Utah. They differ from the Colorado specimens in the duller and more brownish color of the head, thorax, and petiole

seems to be brought nearer our comprehension, if we consider it in connection with another Formicid with equally unusual females, namely, *Lasius latipes*, recently studied by Mr. J. C. McClendon and myself.[1] This ant has females of two different kinds which occasionally occur in the same colony. One of these is such as we should expect to find after an examination of the females in the other species of the genus *Lasius*. The other is a most unusual form, with greatly dilated legs and peculiar pilosity. The female which conforms most closely to the generic type we have styled the α–, the extreme form the β – female. In Colorado, during the past summer, I happened on what I take to be α–, and β – females of another *Lasius* (*L. niger* var. *neoniger*). In the same colony of this species I found two kinds of females differing greatly in the length of the wings and not connected by intermediate forms. The majority of females had very long wings (9 mm.), but in a number of individuals of the same stature these appendages were so short that their tips did not reach beyond the gaster (5 mm.). The former are probably to be regarded as α–, the latter as β– females. Another American ant, in which the normal female is in all probability a β– form, is *Stenamma* (*Aphænogaster*) *tennesseënse*. This female departs remarkably in its small size, glabrous surface, and peculiar epinotal spines from the females of all the other known species of the genus. Here, as in *Formica ciliata* and *F. microgyna*, we may suppose that the α– form has become extinct, or, at any rate, has not yet been seen. Mr. McClendon and myself preferred to regard the occurrence of α– and β– females in *L. latipes* as a case of dimorphism. This involves no contradiction with the following clearer definition of my views.

Since reading the admirable work of de Vries,[2] and especially after some correspondence on this matter with my friend, Prof. Carlo Emery of Bologna, I am strongly inclined to see all these cases of dimorphism in the light of the mutation theory. The β– females would then seem to be striking

[1] Dimorphic Queens in an American Ant (*Lasius latipes* Walsh). Biol. Bull., Vol IV, No. 4, March, 1903, pp. 149–163

[2] Die Mutationstheorie Leipzig, Veit & Co Vol. I, 1901, Vol II, 1903

mutations or saltations of relatively recent phylogenetic origin, which in some species (*L. latipes* and *neoniger*) may continue to exist side by side with the primitive (α–) form. Or the α– form may be a reversional or atavistic occurrence in colonies that normally bring forth only β– forms.[1] In species like *F. ciliata*, *microgyna* and *Stenamma tennesseënse* the α– form has not yet been seen. *Formica oreas* may also be included in the same category, though the female of this species is less extreme,—hardly more so, in fact, than the female of *F. dakotensis*.

A discussion of the more general question as to how far the species, subspecies, and varieties of the Formicidæ show evidence of having arisen by mutation instead of continuous variation would require more space than can be given in this article. In my opinion, the mutation theory not only plausibly indicates how the species, subspecies, etc., have arisen in this group of insects, but also throws light on the development of caste or polymorphism within the confines of the single species. It is difficult, however, with the means at our command, accurately to separate the phenomena of trophic variability from those of mutation proper, as I shall endeavor to show in a future paper.

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[1] Similarly the peculiar wingless, or "ergatoid" males of *Formicoxenus*, *Anergates*, etc., may be regarded as β– males, *i. e.*, as saltatory aberrations or extreme mutations from the normal winged type, which has been suppressed in the phylogeny. It should also be noted that the different ergatoid females of forms like *Leptothorax emersoni* are not continuous variations, but mutations which differ from one another by the presence or absence of whole characters — *e. g.*, ocelli, thoracic sclerites, etc., at the same time that they exhibit true variations, *i e.*, differences in dimensions.

Article XXIX. — SOME NEW GYNANDROMORPHOUS ANTS, WITH A REVIEW OF THE PREVIOUSLY RECORDED CASES.

By William Morton Wheeler.

In the following paper six new gynandromorphous ants are described. The study of these and of the previously recorded cases among the Formicidæ and other insect groups has been greatly facilitated by a perusal of the recent review by Dalla Torre and Friese of all the Hymenopterous gynandromorphs known up to 1899. In the hope of bringing the subject to the notice of American students, I have included an English résumé of the known cases among the Formicidæ, as these singular anomalies are certainly most frequently found and therefore most easily studied among the insects of this family. Of the 80-odd known Hymenopterous gynandromorphs recognized by Dalla Torre and Friese ('99), 19 are ants. Two of these cases, however, are spurious. Their No. 20, *Myrmica lævinodis*, recorded by Cooke ('82) is the same as case No. 19, previously recorded by Smith ('74), and the *Ponera punctatissima* (Case No. 24) is a normal ergatoid male and not a gynandromorph.[1] Omitting these two cases, therefore, and adding the six described in this paper, we have 23 Formicid gynandromorphs, *i. e.*, nearly a third of the total number of Hymenopterous cases. Of these, 15 are honey bees (*Apis mellifica*) and comprise a number of individuals. The explanation of the high percentage of cases contributed by this one species is, of course, perfectly obvious. Similarly the relatively very large proportion of ant gynandromorphs may be readily accounted for. The Formicidæ are not only of all insects, but probably of all animals, the most abundantly represented by individuals, and this greatly increases the chances of finding such anomalies among collected material. And the fact that ants live in communities of workers which are so devoted to their young that they help them to emerge from their cocoons and to divest themselves of their

[1] See Emery '95, pp. 293, 295.

pupal envelopes, readily accounts for a greater survival of adult anomalies among these than among the non-social Hymenoptera and other insects. It is, in fact, rather surprising that the gynandromorphs of so many non-social insects should be able to run the gauntlet of their various ecdyses and metamorphoses and reach maturity. This, perhaps, implies a considerable degree of muscular coördination in these often very asymmetrical creatures.

Dalla Torre and Friese ('99, pp. 92, 93) have adopted the following classification of gynandromorphs:

Group I.

Lateral Gynandromorphs (*i. e.*, differing in sexual characters on the two sides).

1. Left side male, right side female.	a. Head alone.
	b. Thorax alone.
2. Left side female, right side male.	c. Abdomen alone.
	d. Head and Thorax.
3. Decussating, now male on the left, now male on the right, etc.	e. Head and Abdomen.
	f. Thorax and Abdomen.
	g. The whole body.

Group II.

Transversal Gynandromorphs (*i. e.*, differing in sexual characters dorso-ventrally).

1. Dorsally male, ventrally female.	a. Head alone.
	b. Thorax alone.
	c. Abdomen alone.
	d. Head and Thorax.
2. Dorsally female, ventrally male.	e. Head and Abdomen.
	f. Thorax and Abdomen.
	g. The whole body.

Group III.

Frontal Gynandromorphs (*i. e.*, differing in sexual characters antero-posteriorly).

1. Anteriorly male.	a. Head alone.
	b. Head and Thorax.
2. Anteriorly female.	c. Thorax of one, Head and Abdomen of other sex.

GROUP IV.

Mixed Gynandromorphs (combining the peculiarities of the above groups, *i. e.*, lateral, transversal and frontal intermingled).

1. Left side male.
2. Left side female.
3. Anteriorly male.
4. Anteriorly female.
5. Dorsally male.
6. Dorsally female.
7. Decussating.

In certain respects, this classification is as good as any that can be devised at the present time. Perhaps another group should have been established to include cases of *blended* gynandromorphs, such as, *e. g.*, anomalies which have the form of one sex with the color, sculpture or pilosity of the other, since the four groups above given include only *mosaic* gynandromorphs.[1]

Apart from this omission, the classification suffers, moreover, from certain defects that become very obvious as soon as we attempt to consign a given gynandromorph to one of the groups. It is then seen that, strictly speaking, nearly all of these anomalies belong to the fourth group. Pure lateral hermaphrodites are extremely rare, since the majority of cases thus designated exhibit some mingling, or, at any rate, some deviation of the external sexual characters from any conceptual scheme like the above. In tabulating 65 of the known Hymenopterous gynandromorphs, Dalla Torre and Friese find 38, or somewhat over half the cases, belonging to the first, nearly one quarter (16) to the third, and the remaining quarter (18 cases) to the fourth group. Only a single gynandromorph, a honey bee described by Menzel (**'62a**), can be included in group II (*sub.* 1). Hence all the remaining divisions of this group are purely conceptual and empty. Another difficulty is encountered in the detailed classification of cases belonging to the fourth group. If we adopt the classification of Dalla

[1] From a remark on p. 29 of Dalla Torre and Friese's paper, concerning Tosi's case of a female *Chalicodoma muraria* with male coloration, I infer that the authors do not regard cases of this kind as gynandromorphs, but I would maintain that differences in pilosity and sculpture at least are clearly morphological and cannot therefore be lightly set aside.

Torre and Friese in a loose and provisional sense, we find that the Formicidæ, like other Hymenopterous families, present examples of the first, second and fourth groups.

It is, of course, necessary to distinguish accurately between gynandromorphs and hermaphrodites, since both kinds of sexual organs are not necessarily present in all gynandromorphs (*e. g.*, in the case of *Leptothorax obturator* described below). In the great majority of the recorded cases, the nature of the correlation of internal with external sexual characters is absolutely unknown. It is not even certain that a definite correlation exists. The dissection of the smaller Hymenoptera (especially ants) is so difficult and uncertain that one is tempted to refrain from it and to preserve the specimen on account of its rarity, rather than run the risk of destroying it and of obtaining no satisfactory knowledge of its sexual anatomy. Furthermore, gynandromorphous specimens are often accidentally found only after they have been carded or preserved for a long time in strong alcohol. The recorded correlations of external with internal sexual characters, even in insects as large as gynandromorphous honey bees, are contradictory, and may have been influenced to some extent by the expectation of finding hermaphroditic conditions.

Six Gynandromorphous Ants.

1. **Formica microgyna** *Wheeler.*

Fig. 1.

A mixed frontal and lateral gynandromorph; the head being almost purely female, the gaster male, the thorax, petiole and legs male on the left, female on the right side. The specimen is a callow.

Head that of a female, slightly asymmetrical above, owing to the left eye being somewhat larger and more prominent than the right. Apart from some of the coloring, this is the only male character in the head. The mandibles, antennæ, palpi and other mouth-parts are perfectly normal and symmetrical, except that the left antennal scape is somewhat more slender than the right. Thorax symmetrical except in the region of the paraptera and scutellum, where the right side is somewhat

impressed and defective. Left half of petiole low and rounded, exactly as in the male, right half higher and with a sharper border to the scale, as in the female. Gaster male in form and structure. External genitalia those of a normal male, symmetrical, except that the terminal segments are turned somewhat to the left. Legs male on the left side,

Fig. 1. *Formica microgyna* Wheeler. Gynandromorph; male and female.

female on the right, but hardly differing in length on the two sides. The sexual differences between the legs of the two sides are seen in the more slender tibiæ and smaller strigil on the left side. Left wings normal, right wings smaller and dishevelled, apparently in correlation with the defective thoracic region on which they are inserted.

The coloration of the specimen is peculiarly striking. The head is

pure yellow. Teeth of mandibles and ocellar area infuscated as in the normal female. There is a peculiar, black, V-shaped spot between the left frontal carina and the left anterior orbit, a small black spot at the left posterior orbit, another at the outer border of the right frontal carina, one near the right anterior corner of the head, and a broader, oblique, black band extending from the right posterior orbit to the union of the head with the prothorax. On the lower surface there is a slender black band extending from near the insertion of the right mandible to the posterior edge on the same side. Antennal scapes yellow, somewhat infuscated towards their tips, funiculi and palpi black. Thorax black with the exception of the following regions, which are yellow, the boundary lines between the two colors being very sharp: a large irregular spot on the right posterior corner of the mesonotum, a blotch of similar shape and dimensions on the right mesopleuræ, involving the episternum, another large blotch covering the whole right half of the epinotum except its inferior portion. Left half of petiole black, right half yellow, except the postero-inferior portion, which is also black. The line of color demarcation is median and coincides with the difference in structure of the right and left halves of the petiole. Gaster black, with yellow, somewhat infuscated genitalia as in the normal male. In certain lights the right basal portion of the first gastric segment is seen to be suffused with yellow. Legs infuscated, more heavily on the left (male), than on the right (female) side; articulations yellow. Coxæ black on the left side, infuscated on the right, where the anterior surface of the fore coxa is largely yellow. Wings whitish, the left pair with veins and stigma colored more like those of the female than the male.

Whole body opaque, except the upper surface of the gaster which is lustrous as in the male. The hairs on the head and antennal scapes are exactly as in the normal female, the pile and pubescence of the thorax, petiole, gaster and legs as in the male, except for the yellow (female) blotch on the right side of the mesonotum which bears stiffer hairs like those of the normal female. The remaining yellow blotches are bare.

Length 5.75 mm.

This specimen was found moving about clumsily among a few small workers in an incipient colony of *F. microgyna* in Cheyenne Cañon near Colorado Springs, Colo., July 20, 1903. *F. microgyna*, as I have shown in a previous paper ('03), differs from all the known species of the genus in the remarkably small size of the female. This may, perhaps, facilitate the development of anomalies like the one described above, because the male and female are so nearly of the same size.

2. **Polyergus rufescens** *Latr.* subsp. **lucidus** *Mayr.*

This case is somewhat dubious. It is a female with well-developed wings but an extremely small head, hardly half as broad as the head of the normal female and only about two thirds as broad as that of the worker. The antennæ are very short. So far as its form is concerned, the head could be described as that of a very small worker, but the coloring is decidedly blackish and the surface is somewhat more coarsely shagreened than the head of the worker or female. In these particulars the specimen approaches the male type.

Taken near Colorado City, Colo., Aug. 18, 1903, in a flourishing colony of *Polyergus lucidus* with *Formica nitidiventris* as slaves. The nest contained many males and females of the *Polyergus*, but the above was the only anomalous specimen found.

3. **Stenamma (Aphænogaster) fulvum** *Roger* subsp. **aquia** *Buckley* var. **piceum** *Emery.*

Fig. 2.

A nearly complete lateral gynandromorph; male on left, worker on right side. Callow.

Head and antennæ symmetrical, of the worker type. Ocelli absent, but eyes larger and more prominent and antennal scapes shorter than in the normal worker. Funiculus 13-jointed on the left (hence male), 12-jointed on the right, but with the last joint incompletely divided into two, so that the antennæ, like the eyes, present male characters on both sides. Left mandible small, like that of the male, right large, like that of the worker. Thorax asymmetrical, male on the left side, with mesonotum, scutellum, metanotum, remnants of dishevelled wings, and on the epinotum a blunt projection as in the normal male; on the right side the thorax is like that of the typical worker except that the metanotum is distinct. The prominent worker spine is present on the right side of the epinotum. Petiole and postpetiole symmetrical, somewhat intermediate in shape between the worker and male, but much more rounded and thicker set than in either of these sexual phases. Gaster asymmetrical, evidently worker on the right, with broad base, and male on the left, with the greatest breadth nearer the middle. There are five distinct segments as in the male. External genitalia represented only by the left half of the male organs,

but the cerci are present on both sides. No trace of a sting can be seen. Legs of the left side male throughout, long and slender; those on the right side decidedly shorter, of the worker type.

Sculpture of the head differing from that of the worker in having comparatively few clean-cut, longitudinal rugæ, which do not anastomose as in the worker. Interrugal spaces smooth and shining instead of opaque and punctate as in the worker. In its more shining surface the head approaches the male, in the presence of the rugæ, the worker type. The thorax and pedicel are sculptured like the male on the left side and are therefore rather smooth and shining, whereas the right side is rugose and less shining like the corresponding regions in the worker. Gaster shining throughout.

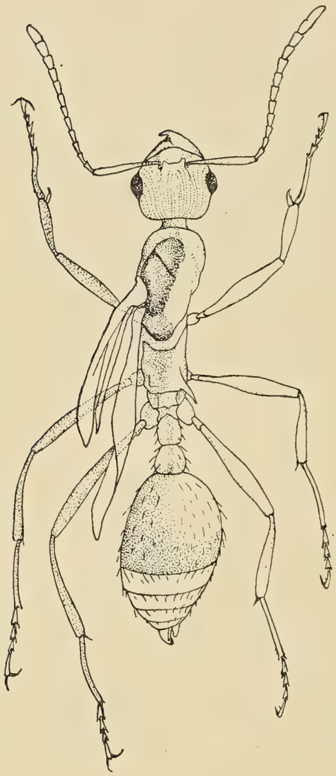

Fig. 2. *Stenamma fulvum* Roger subsp. *aquia* Buckley var. *piceum* Emery. Gynandromorph; male and worker.

Body sordid yellow, *i. e.*, like that of a callow worker, but with the male regions blackened as follows: rugæ of head, which stand out like black lines on a yellow background, left lower surface of head, the left half of the thorax, petiole, postpetiole, first gastric segment and the legs of the left side. The pigment is deepest in the thorax in front of the metanotum. On the right (worker) side the normally intense color of the posterior portion of the first gastric segment is represented by a blackish cloud.

Hairs on the whole head and right half of the remainder of the body like those of the worker, on the left half like those of the male.

Length, 4 mm.

The lateral gynandromorphism is very distinct in this specimen in nearly all parts except the head. In the latter region characters of the two sexes are blended, except in the mandibles, since the eyes, antennæ, sculpturing and coloration of the head show evidence of the male characters extending to

the right, and worker characters to the left side, with nearly perfect bilateral symmetry.

This specimen was kindly given me by Miss Adele M. Fielde, who sent me the following note concerning its capture: "It was found in one of my artificial nests here in the laboratory at Wood's Hole, Mass., Aug. 25, 1903, and must have been recently hatched. Fearing it might be torn by other ants, I at once bottled it in 95 % alcohol. One side was jet black. It seems that the color of this side has lessened in the alcohol. The other side was the usual color of callow *Stenamma piceum.* The nest in which I found it contained queens and workers that had been there a year, but I had lately put in newer ants and a quantity of pupæ from the old wild colony. This ant was probably hatched from the pupæ lately introduced." Miss Fielde also alludes to this specimen in a note at the end of her latest paper (**'03,** p. 624).

4. **Stenamma (Aphænogaster) fulvum** *Roger* subsp. **aquia** *Buckley* var. **piceum** *Emery.*

Fig. 3.

This insect is a normal worker apart from the head, which is intermediate in size between that of the male and worker. The eyes are much larger and more prominent than those of the worker, the one on the left distinctly larger than the one on the right. There are three well-developed ocelli on the vertex. The mandibles are of the worker type but the right

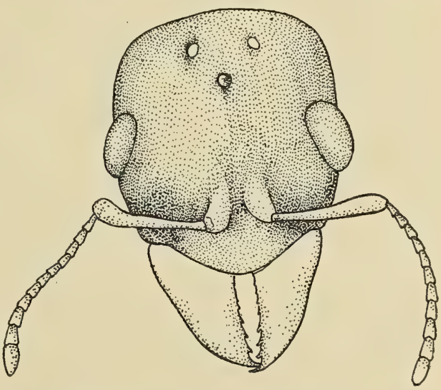

Fig. 3. *Stenamma fulvum* Roger subsp. *aquia* Buckley var. *piceum* Emery. Head of gynandromorph; male and worker.

one is clearly broader than the left. The antennæ are much shorter than those of the worker though both are 12-jointed;

the right scape is somewhat bent and distorted towards its apical end, which is incrassated, like the corresponding portion of the left scape. The sculpturing of the cephalic surface is also intermediate between that of the worker and the male. It is opaque and densely punctate like the male but with distinct indications of the longitudinal, reticulate rugæ of the worker. I regard the specimen as exhibiting gynandromorphism of the blended type in the head only. In certain respects the specimen resembles the above described *Polyergus lucidus*.

Received from Father Jerome Schmitt, O.S.B., who found it near St. Vincent, Pennsylvania, during the summer of 1901.

5. **Leptothorax obturator** *Wheeler.*

Fig. 4.

Incomplete lateral gynandromorph; male on left, worker on right side; head largely, gaster entirely of the worker type.

Head somewhat asymmetrical; the left eye being a little larger than the right, the left half of the clypeus smaller than the right half and separated from it by a deep notch. Left mandible distinctly smaller than the right but similar to it in other respects. Right antenna that of a normal worker; left antenna distorted, with the number of joints (12) peculiar to the worker; its scape only half as long as the right scape, bent toward its distal end; first funicular joint globose and therefore more like that of the male than the worker. Vertex with two ocelli, the left lateral, which is the larger, and the anterior unpaired ocellus, which is much smaller. Thorax nearly symmetrical, that of a male as far back as the paraptera which form a transverse band of uniform width just back of the mesonotum. Behind this region the thorax is decidedly asymmetrical, being male on the left side with a small abortive scutellum, half of the mesonotum and a nearly normal epinotum; worker on the right side with the epinotal spine blunter and more indistinct than in the normal worker. Petiole and postpetiole somewhat asymmetrical, very nearly of the worker type. Gaster purely worker, with well-developed, perfectly normal sting. Legs on the left side entirely male, with slender femora, tibiæ and tarsi; on the right side entirely of the worker type, with femora incrassated in the middle, stout tibiæ and larger strigil. Wings absent on right (worker) side; present on left (male) side, but somewhat dishevelled. When spread out in water the fore wing was found to have a peculiar claw-shaped process on the stigmatic border. Veins, owing

to their pale color, indistinct and difficult to trace, as they are in the wings of normal individuals.

Whole surface of head and pedicel and right half of epinotum sculptured like the worker; symmetrical anterior portion of thorax and left epinotum like the male. Gaster smooth and shining like that of the worker.

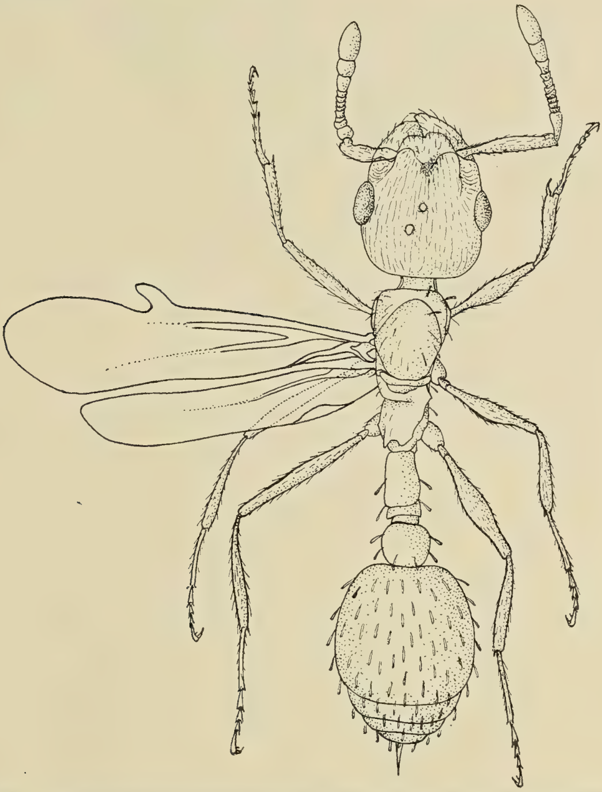

Fig. 4. *Leptothorax obturator* Wheeler. Gynandromorph; male and worker.

Head, petiole, postpetiole, gaster and right half of epinotum beset with the erect, clavate, white hairs so characteristic of the worker. Male portions of thorax with a few scattered, tapering hairs.

Black; mandibles, articulations of legs, lower portion of thorax and pedicel and basal joints of antennal funiculi, yellowish. Wings whitish hyaline.

Length, 2.4 mm.

This specimen was found at Austin, Tex., in a normal col-

ony of *Leptothorax obturator* that had been taken from a live oak gall (produced by *Holcaspis cinerosus*) and transferred to an artificial nest. It hatched Nov. 28 and was seasonally out of place in the colony, since the winged forms of this *Leptothorax* normally make their appearance only during April and May. The gynandromorph lived for several days in the nest and was fed and cared for by the workers. Its movements were very awkward, owing, without doubt, to the differences in the structure of the legs on the two sides of the body, the abortive left antenna and wings.

A former pupil, Miss Margaret Holliday, accomplished the difficult feat of dissecting the reproductive organs from the gaster, which was only .75 mm. in length. These organs were those of a normal worker: two slender ovarian tubules, one on either side. The one on the right side contained a rather large egg in the lowermost follicle. The vagina, sting and poison apparatus were quite normal. No traces of testes could be found, though the organs were carefully stained and mounted in balsam. Hence the specimen was not hermaphroditic.

6. **Epipheidole inquilina** n. gen. et n. sp.

Fig. 5.

A nearly perfect lateral gynandromorph ; left side male, right side female. Mature.

Head very asymmetrical; left half small and clearly that of a male, with large eye, normal male antenna (13-jointed) and very small mandible, with only one basal tooth; right half much larger, female, with normal female mandible (with three large basal teeth) and antenna (12-jointed). Left ocellus large, of the male type; right small, of the female type, the anterior unpaired ocellus intermediate in size between the two. Thorax rather robust, symmetrical, except in the epinotal region where the spine is of the male type (short and pointed) on the left side, of the female type (stout, laterally compressed and very blunt) on the right side. Petiole and postpetiole nearly symmetrical, intermediate between those of the male and female. Gaster somewhat asymmetrical basally, being broader on the right (female) than on the left (male) side. Terminal segments and genitalia turned to the left and slightly twisted. Five segments are clearly discernible. Genitalia asymmetrical, represented by the male valvules

of the left side, the penis and one cercus. There is no visible trace of a sting. The legs are male on the left, female on the right side, differing little in length. The sexual difference is seen only in the larger strigil and the somewhat stouter tibiæ and femora on the right side. Wings perfectly normal, alike on the two sides.

Left side of head opaque, right finely longitudinally rugose, as in the female. Left mandible smooth, impunctate; right with coarse piligerous punctures. Mesonotum, paraptera and scutellum shining, intermediate in character between the male and female. Pronotum,

Fig. 5. *Epipheidole inquilina* n. gen. et n. sp. Gynandromorph ; male and female.

pleuræ and epinotum on left side finely reticulate-punctate (male), on the right more coarsely reticulate-rugose as in the female. Petiole and postpetiole subopaque, finely reticulate-punctate, except dorsal surface of postpetiole, which is smoother. Gaster glabrous, shining.

Hairs on the left half of the body like those of the male, long, slender and tapering; on the right half stouter, and distinctly obtuse or even clavate at their ends, as in the female. Hairs on the antennæ and legs short and appressed as in both sexes.

Left side of head and ocellar region black, like the head of the male; left mandible pale yellow; right mandible, clypeus and right anterior portion of head reddish brown gradually becoming darker on the posterior corner. Thorax reddish brown, the left (male) half being

distinctly darker than the right (female) half. Pleuræ on both sides paler than the dorsum. Pedicel and gaster reddish brown, left half of latter distinctly darker than the right half. Gastric incisures, genitalia, mandibles and legs pale brownish yellow. Wings grayish hyaline, veins and stigma yellow, the latter not very conspicuous.

Length, 3 mm.

This interesting species, of which a full description will be published in a forthcoming paper, was found during the past summer in three different nests of *Pheidole pilifera* Roger var. *coloradensis* Emery, near Colorado Springs, Colo. It is, in all probability, a parasitic species, like *Anergates* and *Epœcus*, and, like these forms, has no workers. Another very distinct new species, apparently of an allied genus and also without workers, occurs as a parasite in the nests of *Pheidole ceres* n. sp., in the same territory.

The above described gynandromorph was found together with several normal males and females in a *Ph. coloradensis* nest at Broadmoor, Aug. 11. The mother queen of the parasitic colony had a very abnormal gaster, the basal segments being greatly inflated and containing the telescoped and somewhat distorted terminal segments. This fact is suggestive in connection with Menzel's discovery (*vide infra*, p. 679) that the queen bee that produced so many gynandromorphs in the Eugster hive had an abnormal abdomen.

Formicid Gynandromorphs Described by Previous Authors.

1. Tischbein ('51, p. 295, and '53, Taf. III, figs. 2, 2*a*, 2*b*,) and Klug ('54, pp. 102, 103). *Formica sanguinea* Latr.

Fig. 6.

Nearly complete lateral gynandromorph; male on left, worker on right side. In the head, the left mandible, outer third of clypeus, antenna, eye, median and lateral ocellus, are male, though the black coloring also covers the smaller right ocellus. Remainder of head red (worker). Thorax and petiole male on left, worker on right, the line of division being median on the dorsal surface, and the structure of the meso-, meta- and epinotum correspondingly asymmetrical. Left half of thorax black, right half red, sharply divided above; on the ventral

surface the dividing line is median only on the prothorax but passes outside the middle and hind coxa on the male side. Petiole sharply divided into a black male (left) and a red female (right) half. Gaster black, with a large red blotch on the right side at the base of the first segment. The pilosity and sculpture of the left side are male, those of the right, worker. External male genitalia are present on the left side and the anal sternite is present only on this side. Remaining

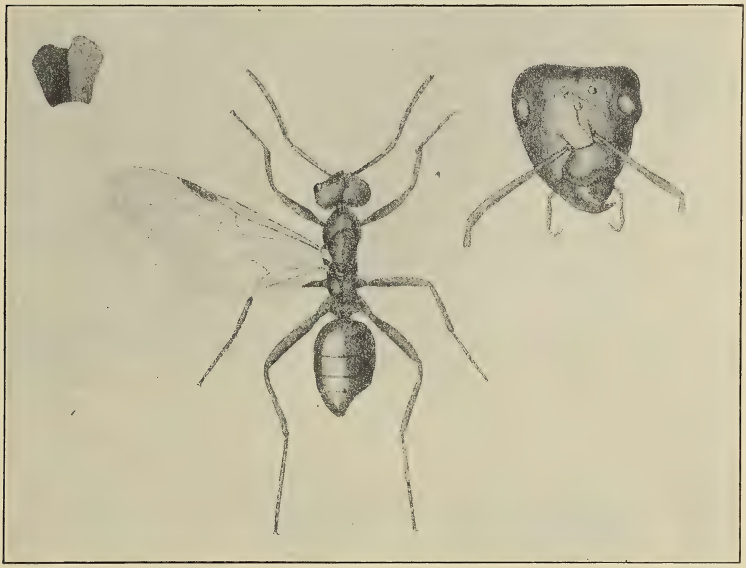

Fig. 6. *Formica sanguinea* Latr. Gynandromorph; male and worker; dorsal view of entire insect, with petiole and head. (After Tischbein.)

organs of this region "quite malformed." All the legs, and the coxæ of the male side, are red and hence of the worker type. Wings of the male side of normal size, but their veins and stigma are paler and hence more like those of the female. There are, of course, no wings on the worker side.

2. Roger ('57, pp. 15–17, Taf. I, fig. 2). *Tetramorium simillimum* (Smith) Mayr (= *Tetrogmus caldarius* Roger).

Fig. 7.

Lateral gynandromorph; male on left, worker on right side. In the head the left mandible, eye and antenna, median and left lateral ocellus and the sculpture and color of the left side, are male, the

remainder of head of the worker type. In the thorax the left (male) side is very convex, the right (worker) side flat. Left side black and more strongly sculptured than the right. Wings had been present on male side as shown by their stumps. Legs of left side slender, nearly

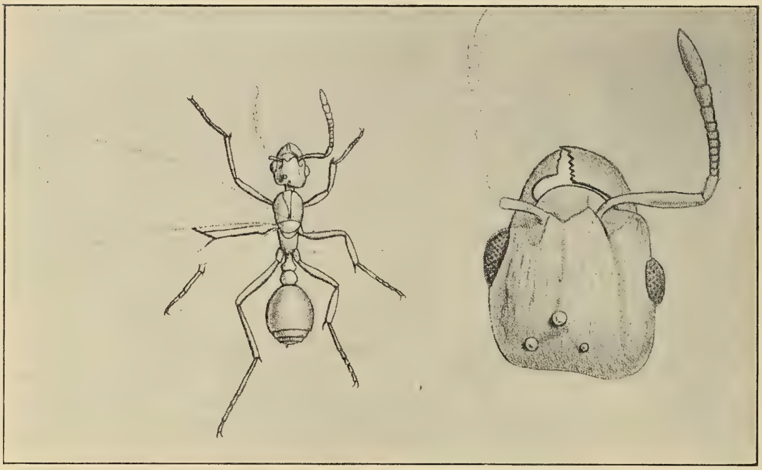

Fig. 7. *Tetramorium simillimum* (Smith) Mayr. Gynandromorph, male and worker. Entire insect with head more highly magnified. (After Roger.)

twice as long as those on the worker side. Petiole, postpetiole and gaster apparently of the worker type, though the tip of the gaster had been broken.

3. Meinert ('60, p. 331). *Tetramorium simillimum* (Smith) Mayr (=*Myrmica caldaria* Roger).

Mixed frontal gynandromorph. Head male, thorax and abdomen female, with the exception of the thoracic dorsum which resembles the corresponding portion of the male in color and sculpture.

4. Meinert ('60, p. 327). *Myrmica lobicornis* Nyl.

Mixed frontal gynandromorph. Head female in size; thorax and external genitalia, as well as the color and sculpture of the body, male Wings intermediate between those of the two sexes.

5. Forel ('74, p. 142.) *Myrmica ruginodis* Nyl.

Frontal gynandromorph. Body perfectly symmetrical. It is rather a male, as the gaster has five segments in addition to the petiole and postpetiole and the external genitalia are male. The epinotum

has only two tubercles instead of spines, but the eyes are much smaller than those of the male, and hence more like the female. The head is also a little larger than the head of a male, but both its form and color are intermediate between the two sexes. Antennæ 13-jointed as in the male, but in color and form recalling the antennæ of the female. There are also two distinct red bands on the anterior portion of the mesonotum, which are never found in the male. Sculpture of head and epinotum more rugose and less shining than in the male.

6. Forel ('74, p. 140). *Formica exsecta* Nyl.

Incomplete lateral gynandromorph. Worker, with some portions of the left side male. Stature of ordinary worker. Male portions: a longitudinal black band under the head, left half of pronotum, a large V-shaped, black blotch on mesonotum, a black protuberance (scutellum?) and vestiges of alar articulations. All the rest worker. Epinotum malformed.

7. Forel ('74, p. 141). *Formica rufibarbis* Fabr.

Mixed gynandromorph, *i. e.*, with male and female characters mingled on the two sides. Halves of head identical, but of such a character that it is impossible to say whether they are male or female; in form the head is exactly intermediate between the two sexes. Both antennæ 13-jointed as in the male, but scapes too long in proportion to funiculi for this sex. Mandibles indistinctly denticulate, particolored reddish black and brown, intermediate between male and female, as are also the size and conformation of the eyes and ocelli. Whole head more robust than that of the male, smaller than that of the female; black (hence male). Thorax indeterminate; right half of epinotum yellowish red, left half black, whereas the right half of the scutellum and petiole is black, the left half reddish yellow; hence the epinotum is female on the right, male on the left side; whereas the scutellum and petiole are male on the right and female on the left. Since in the normal female the thorax is more or less red or black according to individual variation, and has the same form as that of the male, in which it is almost entirely black, it is impossible to determine the sex of these parts. The three pairs of legs are symmetrical, yellowish and have rather the form of the female. The wings, being the same in both sexes, are indeterminate in the gynandromorph. Gaster apparently female, globular, very small, with five segments, excluding the petiole. Anus round, encircled by hairs as in the female, but it opens above into a transverse, eciliate slit, situated between the hypopygium and pygidium as if forming a second anus. The anus proper is cut into the hypopygium. This gynandromorph was taken flying with copulating males and females

of its own species and hence must have exhibited the reproductive instinct. Dissection was not successful, but nevertheless exhibited the following points: Poison vesicle very distinct, almost normal, but short, thick-set and with small pulvini. On the left of the stomach was a perfectly normal ovary, with tubules full of eggs of the normal form but very small. On the right, rather near the middle and superficially placed, there was a peculiar little organ, evidently vestigial, but of unknown significance, perhaps the remains of the testis. Accessory gland of the poison apparatus very large but flattened and abortive. Near the cloaca there were some vestigial chitinous appendages (male genital valves?). Alimentary canal partly abortive. On the whole the genitalia were much atrophied; their female nature on the left was certain, but doubtful on the right.

8. FOREL ('74, p. 140). *Formica truncicola* Nyl.

Mixed gynandromorph, the characters of the two sexes being very intimately and irregularly intermingled. Right half of head entirely female, left half male, but incompletely. Left mandible smaller than right, 7- instead of 8-toothed (the male mandible is edentulous); left antenna 12-jointed, but the 12th joint is half divided (the male has 13 joints). Thorax red, blotched with black, predominantly female, but somewhat male on the left side. Externally the gaster appears to be male, with six segments (not counting the petiole); external genitalia male, quite alike on the two sides. Dissection showed perfectly normal, bilaterally symmetrical male organs. Beneath these the structures were confused, though an ovary, smaller than that of the normal female, but larger than in the worker, was isolated. Like the female ovary, it had a number of tubules, each containing numerous eggs, but all were very small and immature. Another organ, in all probability a vestigial poison-sac, was isolated. This does not exist in the male. Hence the specimen was a true hermaphrodite, with two entirely normal testes and at least one almost normal ovary.

9. FOREL ('74, p. 142). *Polyergus rufescens* Latr.

FIG. 8.

Approximately lateral gynandromorph, worker and male. Head red, worker throughout, except for a black (male) blotch on the right under side. Prothorax entirely worker. Right fore leg a little larger than the left. Mesothorax, epinotum and petiole worker on the left and male on the right side, the demarcation being very sharp and in the median line. Male side of thorax somewhat atrophied, but nevertheless with a vestigial half scutellum and metanotum, a perfect fore and a dishevelled hind wing. Middle and hind leg worker on the left, male on the right side. Three anterior gastric segments divided, both dorsally and ventrally, along the median line into a male right and a

worker left half. Ventral laminæ of the same configuration on the two sides. But the right half of the second tergite is fused not only with the corresponding left half but also with the left half of the third tergite; the two latter are therefore separated from each other only as far as the median line. The left half of the third tergite thus separated, ends toward the middle in a rounded edge. Externally the fourth and fifth segments are entirely male, with nearly normal sternites and tergites. There is a very small sixth segment, partly defective on the left side, composed of a pygidium (tergite) and a hypopygium (sternite). External genitalia entirely male, paired, of the ordinary size, consisting of the three plates and the three pairs of external valvules, exactly as in the normal male. Dissection showed the probable occurrence of a small poison-sac opening into the cloaca to one side of the rectum, but without distinct pulvini. The vagina was almost normal and received on the left a normal oviduct terminating in a normal worker ovary of six or seven tubules containing eggs. On the right was a perfectly normal vesicula seminalis opening below into the vagina and ending anteriorly in a vas deferens. The latter terminated in front, in a very complex organ comprising on one side several distinct ovarian tubules with eggs and on the other a thick, irregular, granular appendage, probably a vestigial testis.

Fig. 8. Reproductive organs of hermaphroditic and gynandromorphic *Polyergus rufescens* Latr. Ventral view. To the left ovary and testis with vas deferens and vesicula seminalis; to the right ovary with oviduct. (After Forel.)

This specimen is of considerable interest, as it was captured carrying a larva of *Formica rufibarbis* and participating with normal workers of its own species, in a slave-making raid. This proves, according to Forel, that the intelligence of ants has its seat in the brain. Even the female of *Polyergus* does not exhibit such instincts. The head of the individual above described was completely worker and the remainder of the body, though to a considerable extent male, had no effect in counteracting the normal worker instincts.

10. Forel ('74, p. 139). *Polyergus rufescens* Latr.

Fig. 9.

Approximately lateral gynandromorph. Right half of head almost exactly like that of the male (black); left half worker (red); the former with a very short mandible, an enormous eye, and an antenna with

short scape and long funiculus; left side with a large, falciform mandible, very small eye and worker antenna. Demarcation between black (male) and red (worker), sides extremely sharp and nearly median. Nevertheless the anterior ocellus is completely on the male side; it is very large like the right ocellus, whereas the left ocellus is small (worker type). Pronotum worker, except for two black spots on the right side. Mesonotum worker on the left and male on the right side, which has dishevelled wings and a small scutellum. There are, of course, no traces of wings on the left side. Epinotum and petiole worker, with the exception of some black (male) blotches on the right side. Right legs partly male; left legs worker. Externally the gaster is entirely worker. Stature that of a worker. Observed alive in an artificial nest in which it lived for two weeks. The movements of the right and left mandibles were perfectly coördinated. The specimen was not dissected.

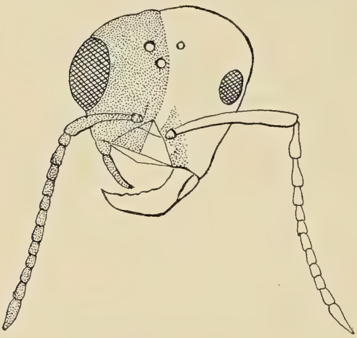

Fig. 9. *Polyergus rufescens* Latr. Head of gynandromorph; male and worker. (After Forel.)

11. Smith ('74, p. 147) and Cooke ('82, p. 30). *Myrmica lævinodis* Nyl.

"It combines characters of the male, female and worker: the right side is entirely worker, on the left side the head is female, hence we see an ocellus and antenna exhibiting the characters of the female; but the left side of the thorax is certainly male and consequently the mesothorax has, in front, a deeply-impressed oblique line — in an ordinary male of this species there are two such lines which form a V-shaped space, which is not found in either the female or the worker — the metathorax on the left side, is destitute of the spine which characterizes both the female and the worker, the legs on the same side are all male, being longer and much more slender than those of the other sexes."

12. Adlerz ('86, p. 82). *Leptothorax tuberum* Fabr.

Incomplete lateral gynandromorph. Right side exclusively worker, left partly male and partly worker. Left half of head male, pronotum worker, mesonotum, paraptera, scutellum and mesopleuræ male; metanotum and epinotum worker; legs male with worker coloring. Petiole and postpetiole between male and worker, but left side darker

like that of the male. Gaster as in the worker, but on left side of tip with an incomplete sternite representing the seventh segment of the male. There is a projecting, irregular penis, with its genital valves so abortive on the right side as to be recognizable only with difficulty. At the right of the penis is a rather irregular sting. Internal male genitalia represented by two vesiculæ seminales, the somewhat larger left one receiving a vas deferens which is not represented on the right side. There were no testes. Below and to the right of the male genitalia an ovary was found, consisting of one large and two small tubules, of which only the large one contained a mature egg in the lowest follicle. This ovary was connected with an oviduct which opened into a vagina. No traces of the poison gland or vesicle were found.

13. WASMANN ('90, p. 299). *Myrmica lævinodis* Nyl.

A mixed gynandromorph, male and worker, with only the color of the head like that of the worker and the ocelli much smaller and more closely aggregated than in the male. In all other respects the specimen was a normal male.

14. WASMANN ('90, p. 298). *Myrmica scabrinodis* Nyl.

Approximately lateral gynandromorph with left half of the body almost entirely that of a worker, whereas the right half is that of a normal male. Left (worker) half of head larger than the right, opaque, coarsely and longitudinally rugose, with a large yellowish red blotch above, sharply delimited on the right side as far as the middle of the face, extending back on the left to the middle of the side of the head as far as the first third of the superior orbit, and anteriorly to the antennal insertion, which is encircled by a black ring. Mandibles, antennæ and left half of clypeus yellowish red, the remainder of the head black. Right half of head smaller, more finely longitudinally furrowed and therefore more shining (male). Right eye larger (male), left smaller (worker). Ocellus lacking in that portion of the vertex corresponding to the left side of the head (worker). The two remaining ocelli are present, the median lying rather accurately on the boundary of the black side of the head, but still entirely on that side. Right mandible male in size, shape and number of teeth, but reddish yellow (worker), whereas normally the male mandibles are reddish yellow only at their tips. Left, much more robust, mandible entirely worker. Antennæ both alike, 13-jointed, almost purely male, but very short and sparsely hairy in contradistinction to the long, abundant pilosity of the normal male antennæ in *Myrmica scabrinodis*. They are also lighter in color, being almost uniformly reddish yellow as in the worker.

15. Perkins ('91, p. 123). *Stenamma westwoodi* Westw.

Approximately lateral gynandromorph. Left side worker, right side male, gaster apparently worker. "*Left half:* Head red, with darker cloud reaching from vertex to eye. Mandible very large, with 7 teeth. Antenna 12-jointed, testaceous, with pale hairs, first joint of flagellum longer than next two together; these and the following joints much wider than long; apical joint very large and stout, as long as two preceding; scape very long and bent, as long as many joints of flagellum. Eye small. Mesothorax red. Second node of petiole lighter. Abdomen from middle line testaceous brown. Legs shorter and thicker.

"*Right half:* Head dark brown. Mandible small (the ant being carded I cannot clearly make out the form of the right mandible). Antenna 13-jointed, dark, thin, with pale hairs; first joint of flagellum stouter than next, but subequal to it; the following joints all much longer than wide; apical joint as long as on left side, but not nearly so stout; scape short and straight, only about as long as two joints of flagellum, and *per se* barely half the length of that of left side. Eye larger; more than twice the size of the other, and much nearer to the base of antenna. Mesothorax dark, laterally with two rough projections, apparently tegulæ. Second node of petiole darker. Abdomen from middle line dark brown. Legs longer and thinner.

"The form of the abdomen, so far as I can make out in this specimen (set on card), is that of the worker. The shape of the mesothorax is unsymmetrical bilaterally. Length, about 3 mm."

16. Forel ('92, pp. 268–270, pl. xvi). *Azteca instabilis* Smith.

Fig. 10.

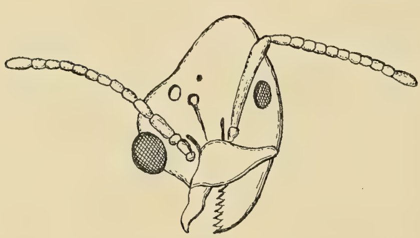

Fig. 10. *Azteca instabilis* Smith. Head of gynandromorph; male and female. (After Forel.)

Lateral gynandromorph; male on the right, female on the left, at least as far back as the gaster. The latter is somewhat corneous and entirely male. Head clearly divided down the middle, except the median ocellus which is male. The small male mandible is entirely without teeth. External genitalia entirely male. Thorax narrow, legs on the male side slender, those of the female side more robust.

17. KLAPÁLEK ('96, xxviii, pp. 1–4, 2 Figs.). *Camponotus ligniperdus* Latr.

FIG. 11.

Incomplete lateral gynandromorph, worker and male. Body much distorted, differently colored on the two sides. Head very irregular; clypeus oblique; left mandible large, 5-toothed as in the worker, right small, as in the male. Left antenna worker, right male. Left eye apparently somewhat larger than right; only two ocelli, the anterior on the middle line, the other on the right side. Pro-, meso- and epinotum asymmetrical; left side without vestiges of wings, right with small stumps. Petiolar node like that of male. Gaster in front on left side much broader than on the right; left half of gastric segments with many more hairs than the right, where they are either entirely lacking (first and third segments) or very spare. Sixth and following segments entirely as in the male, the last bearing the external, completely developed male genitalia. Joints of left stouter than those of the right legs. Left mandible and anterior portion of head reddish brown, remainder of head blackish brown; left half of thorax, scutellum and first gastric segment yellowish brown, right half and remaining segments blackish brown, genital segments grayish yellow. Klapálek concludes that the specimen is a lateral gynandromorph, with the left side (excluding the sixth and succeeding gastric segments) worker, the right side male. The dorsal line of separation is accentuated in the head, clypeus and gaster by a fine furrow, elsewhere by a difference in coloration. The division is

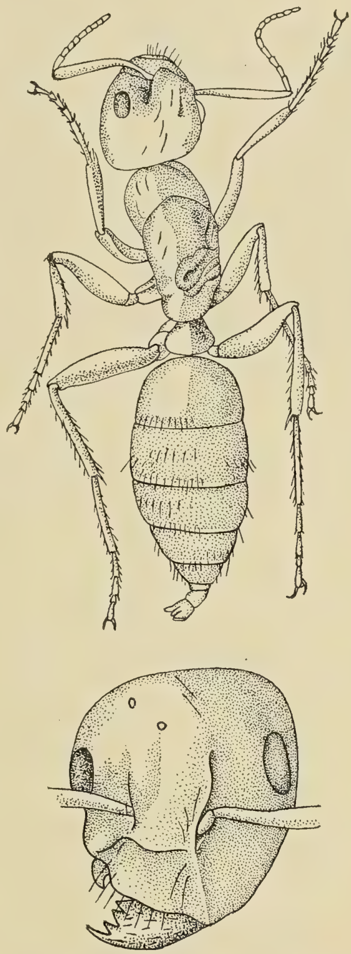

Fig. 11. *Camponotus ligniperdus* Latr. Gynandromorph; male and worker. Entire insect and head of same. (After Klapálek.)

completely median, even on the ventral surface till it turns to the left to terminate on the fifth gastric segment external to the left half of the sixth, so that the sixth and following segments are completely male, thus disturbing the symmetry of the two halves of the body.

Theoretical Considerations.

Up to the present time, all attempts to offer a hypothetical explanation of gynandromorphism among insects in general, and ants in particular, have proved to be unsatisfactory. This was inevitable, since any such explanation must necessarily rest on more general hypotheses concerning the determination of sex and the significance of fertilization. Moreover, all the leading hypotheses from those of Dönhoff ('60) down to that of Boveri ('02), have centred about the gynandromorphous honey bees. This was unfortunate because it was inevitable that the question should be complicated by the Dzierzon hypothesis of the origin of male bees from parthenogenetic, of worker and queen bees from fertilized eggs. The Dzierzon hypothesis in its strict formulation has never been fully demonstrated [see *e. g.*, Pérez ('78)]. Its tacit extension to the ants has recently received a severe blow in the researches of Reichenbach ('02), who has shown that the workers of *Lasius niger* may lay parthenogenetic eggs and that these may develop into workers instead of males, as the Dzierzon theory demands. And quite recently Mrs. A. B. Comstock has independently obtained the same results in queenless artificial colonies of *L. niger*, var. *americanus* (*in litteris*). It is probable that in ants, as in the bees, the males normally make their appearance only at certain seasons and it is quite possible that they may arise either from parthenogenetic or fertilized eggs, their sex depending on other conditions. It is clear that both males and females of many insects presenting occasional gynandromorphs of the very same character as those of the honey bee must develop from fertilized eggs. And, furthermore, there are plenty of cases in which parthenogenetic eggs give rise to females instead of males (viviparous Aphides, Phyllopoda, etc.). I conclude from these facts first, that we must endorse von Buttel-Reepen

('03) when he maintains that we are not yet justified in applying apicultural theories to the social wasps, ants and termites, since all of these groups may follow different laws in sex and caste determination; and second, that we would do well to regard parthenogenesis and sex-determination as independent problems, just as it is an obvious advantage to distinguish accurately between the phenomena of sex and those of heredity. If we accept von Lenhóssek's hypothesis ('03) of sex determination in the egg previous to fertilization, there can be no question concerning the truth of this assertion.

With these considerations in mind, we are prepared to undertake a brief critical study of some of the leading hypotheses of gynandromorphism. Dönhoff ('60) appears to have been the first to seek for the causes of this singular phenomenon when he advanced the two following suppositions to account for the structure of a frontal gynandromorph of the honey bee:

"1. It is probable that the egg, from which this animal developed, contained two yolks, one of which was fertilized, the other not. In the one yolk a drone had begun to develop, in the other a worker. Both eventually fused to form a single animal.

"2. According to the Dzierzon theory of the origin of drones from unfertilized eggs, the developmental process will admit of a simpler explanation. The egg, namely, contains the male individual potentially, the spermatozoon the female egg. The development of all animals consists in the fusion of the spermatozoon with the germ of the egg. In the development of the bee the spermatozoon-germ predominates, so that in fertilization this (female) element develops. In the present case both have developed, but so incompletely that the germ of the spermatozoon has given rise to the head and thorax, the germ of the egg to the abdomen of the insect."

These paragraphs may be restated in modern cytological phraseology, thus:

1. The gynandromorphous bee may have originated from two eggs, matured in a single ovarian follicle and enclosed in the same chorion. The eggs fused just before or after fertiliza-

tion, but only the female pronucleus of the egg nearest the micropyle united with a male pronucleus derived from one of the spermatozoa that had entered the egg while it was passing the orifice of the receptaculum seminis.

2. The animal in question may have arisen from a single egg in which the female and male pronuclei did not unite to form a cleavage nucleus, but each independently underwent cleavage and gave rise to the embryonic nuclei. The descendants of the male pronucleus gave rise to female, those of the female pronucleus to male organs of the adult gynandromorph.

It is evident that both suppositions are built on the Dzierzon hypothesis and suffer from this dubious support and from the fact that they are really applicable to gynandromorphs of the social Hymenoptera only. Nevertheless, as I shall show in the sequel, it is possible to give Dönhoff's views a more acceptable meaning.

Wittenhagen ('61) and Menzel ('62) advance no less than seven hypotheses to account for honey bee gynandromorphs. Some of these can be eliminated as they deal with such conceptions as "hohe Potenzierung der männlichen Wesenheit" of the egg, etc., as well as conditions peculiar to bees, and consequently inapplicable to gynandromorphs in general. Two of Menzel's hypotheses, however, are still worthy of consideration:

1. Gynandromorphs may be produced by disturbances in the even tenor of the developmental process. Hence the origin of local defect, which expresses itself in certain portions of the body as male characteristics.

2. Temporary disturbances in the care of the brood, perhaps in the whole economy of the hive.

In other words, the sexual mosaic of the body may be the result of local inhibition of growth or uneven distribution of nutriment to the tissues during embryonic or post embryonic development.

Later, after investigating the famous Eugster hive, which had produced great numbers of gynandromorphous bees (87 of which were dissected by von Siebold!), Menzel ('65) came to

the conclusion that some malformation of the internal reproductive organs of the queen must be responsible for the production of these anomalies.[1]

He suggests that the egg may have passed the opening of the receptaculum so slowly or in such a position that the spermatozoa entered too late and were thus unable to bring about a complete feminization of the egg. In certain respects this view is an adumbration of Boveri's recent hypothesis.

Von Siebold's hypothesis ('64) that gynandromorphous bees are the result of an inadequate number of spermatozoa entering the egg, may be rejected, since we now know that even during normal polyspermy only a single spermatozoon fuses with the female pronucleus. In fact, if polyspermy is at all concerned in the production of gynandromorphs, the very opposite of von Siebold's hypothesis would be more probable, as shown by Boveri.

In the concluding paragraphs of his recent remarkable paper on "multipolar mitoses," Boveri ('02, pp. 86, 87) advances the following hypothesis to account for gynandromorphous development:

"When a bee is a drone on the right side and a worker on the left, the right half has developed as a parthenogenetic, the left as a fertilized egg; the right, therefore, like an egg containing only maternal, the left like one containing both kinds of chromosomes. On the basis of this consideration, and since it has been possible to show that in the sea-urchin egg we can produce asymmetries of a definite kind by means of unequal chromatin combinations in different regions of the egg, the conclusion is inevitable that the cause of insect asymmetries that consist in a mosaic of male and female parts, must be sought in nuclear differences. And in the case of purely symmetrical hermaphroditism under discussion, we cannot have recourse to dispermy, but to some other abnormal distribution of the chromatin, such as I have found in sea-urchin eggs, where one of the half blastomeres contains only maternal, the other mingled male and female chromosomes, and hence,

[1] *Confer* the observation recorded on p. 666 concerning the malformation of the queen *Epipheidole inquilina.*

if the cause lies in the chromatin, the very thing that must be postulated for hermaphroditic bees. Owing to the peculiar conditions under which the bee develops, the occurrence of this anomaly is obviously greatly favored, inasmuch as i appears possible that the egg nucleus may undergo cleavage even before its copulation with the sperm nucleus, owing to its parthenogenetic propensities, so that the sperm-nucleus may chance to fuse with one of the cleavage nuclei. This fusion could even be delayed till later cleavage stages, and polyspermy — which is known to occur in the bee — might bring about the copulation of sperm-nuclei with certain derivatives of the egg-nucleus and not with others. In this manner might arise such manifold mixtures of male and female characters, as have actually been observed."

This passage clearly shows that Boveri is in essential agreement with previous authors in accepting the Dzierzon hypothesis and the view of sex determination which it implies. In discarding this portion of the hypothesis as perhaps inessential and inapplicable to many cases of gynandromorphism, I have no desire to dissent from the fundamental conception of my esteemed friend and teacher. This fundamental conception, which implies that the peculiar chromosomal constellation of the nuclei in a given organ of the body is responsible for the peculiar characters of that region, is too well substantiated by the brilliant experimental work of Boveri and others, to be lightly set aside. This view readily accounts for hereditary phenomena like those of blended and mosaic hybridism. It may also be used to explain not only the mosaic characters of hermaphrodites and gynandromorphs (which, as we have seen, are not necessarily the same) but may be extended, with modifications, to cases like the "Hahnenfedrigkeit" of senile hen birds, the viragoism of aged women, to pathological cases like "mental hemaphroditism" and sexual inversion in human beings, and to the effects on the soma of castration, injury to the gonads, etc. Some of the latter cases are, perhaps, traceable to ontogenetic or trophic changes affecting the chromosomal characters in different parts of the body. Of course, the theory of internal secretions is not precluded in these cases.

Returning to the insect gynandromorphs, I would restate the various possible causes in the spirit of Boveri's hypothesis, as follows:

1. A gynandromorph may, perhaps, arise from a pair of eggs which have fused, like zur Strassen's giant eggs of *Ascaris*, to form a single egg with two egg-nuclei (Dönhoff). These eggs may have been of different sex originally (v. Lenhóssek) or may become different through the non-fertilization of one nucleus and the fertilization of the other (Dönhoff, Boveri).

2. It is possible that the egg nucleus of a single egg may either undergo cleavage prematurely or receive the spermatozoa too late, so that in cases of polyspermy, so general in insects, the resulting cleavage nuclei may unite with different sperm-nuclei, or in part develop parthenogenetically, thus giving rise to different chromosomal constellations in the cells that ultimately go to form different parts of the body (Boveri).

3. It is conceivable that the somatic peculiarities of unisexual gynandromorphs at least, may be the result of trophic disturbances during the postembryonic, *i. e.*, larval or pupal development (Wittenhagen, Menzel). These disturbances may, perhaps, be analogous to those which cause viragoism, "Hahnenfedrigkeit," etc., in other animals, and may depend on pathological changes in the chromosomal conditions of certain tissues.

Two peculiarities in the development of the normal insect egg are obviously favorable to the formation of both mosaic and blended gynandromorphs: First, polyspermy, which would favor the conditions mentioned in the second hypothesis (Boveri); and second, the syncytial nature of the egg in its cleavage and preblastodermic stages. The latter condition permits of a free migration of the cleavage nuclei to different parts of the egg and the consequent development of mixed or blended characters. On the other hand, the absence of such migration or its limitation, would readily lead to the more definite cases of frontal, transversal and lateral gynandromorphism.

In conclusion we may say that however valuable the above

suppositions may be as working hypotheses, we can have no genuine understanding of gynandromorphism till this anomaly can be produced experimentally. This will probably be a difficult task to accomplish in insects, owing to the impossibility of fertilizing their eggs artificially and the difficulty of studying the nuclear phenomena. On the other hand, in the lower invertebrates, where all this is feasible, the secondary sexual characters are very feebly developed. Possibly the lower vertebrates (fishes, *e. g.*) may afford better opportunities for such experimental studies.

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Article XXX. — SKULL OF TRICERATOPS SERRATUS.

By Richard Swann Lull, Ph.D.

Plate LIX.

The American Museum Expedition of 1902, under Mr. Barnum Brown and the writer, which was sent by Professor Osborn into the Laramie formation of Montana had the good fortune to secure, among other material, a fine specimen of *Triceratops serratus* Marsh. The exact locality in which the specimen was found was in the wall of Hell Creek Cañon, some twenty-five miles from the Missouri River, and one hundred and thirty-five miles northwest of Miles City, Montana. The unconsolidated sand matrix has been entirely removed from the skull, thus affording an exceptional opportunity for the study especially of the remarkably preserved palate.

Through the courtesy of Professor Charles E. Beecher the writer was permitted to study the type skulls of *Triceratops prorsus* and of *T. serratus* which are preserved in the Peabody Museum at Yale University. This confirmed the opinion already formed that the American Museum specimen is referable to the latter species. The agreement between the specimens is close, the main points of difference being the inferior size of the type specimen, which is evidently that of a younger animal, and that the median ridge of the parietal crest or frill is not so prominent in the American Museum specimen; nor are the bony projections along the ridge quite so conspicuous as in the type; but in general proportions, the form and arch of the frill, the shape of the orbit and other points mentioned by Marsh in his specific definition the resemblance is very close.

Triceratops serratus *Marsh.*

Marsh, O. C., 1890, Amer. Jour. Sci. (3) XXXIX, p. 81.

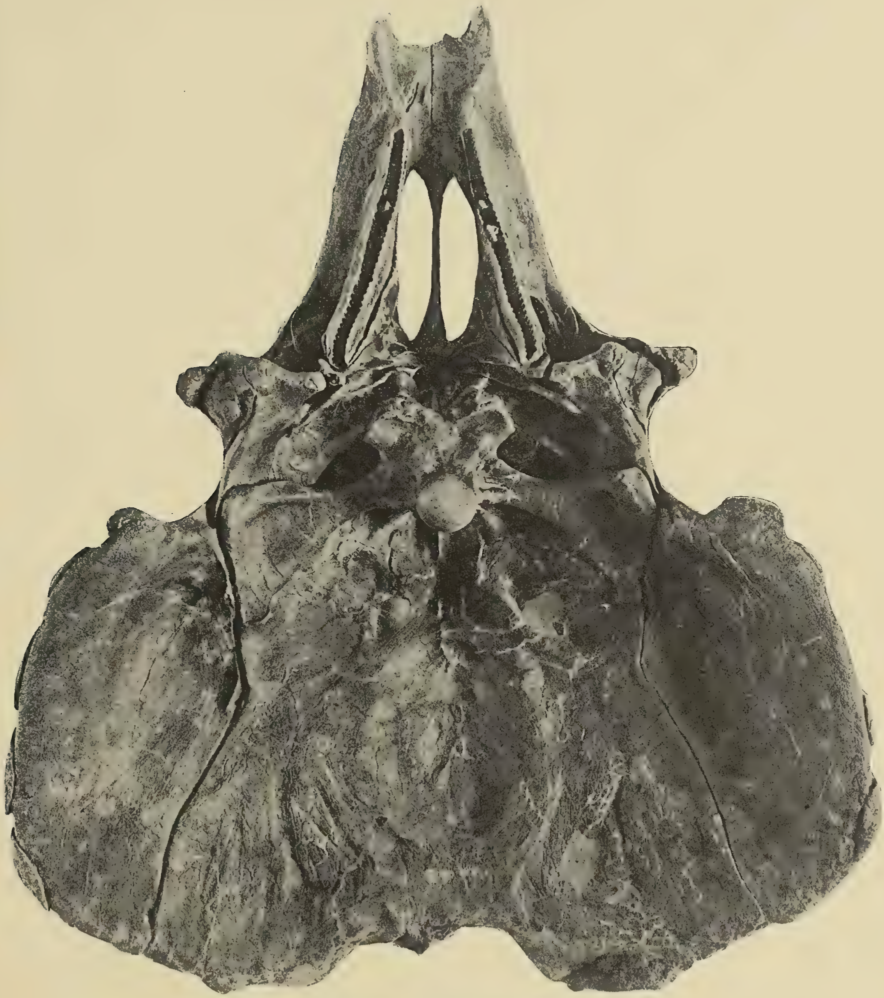
Marsh, O. C., 1890, Amer. Jour. Sci. (3) XXXIX, p. 425, pl. v, fig. 2; pl. vi, figs. 1–6.

Marsh, O. C., 1896, Sixteenth Annual Report U. S. Geol. Survey, p. 208; pl. lx, fig. 3; pl. lxi, figs. 7, 9, 10.

Materials. — The skull lacks only the distal portions of the postfrontal horn cores, the nasals and their horn core, and a portion of the premaxillary bones. The rostral bone was found displaced but a short distance to the rear on the right side of the muzzle, while on the other side lay the left mandible in perfect condition. The coössified right angular and articular, together with portions of both splenials, were found beneath the skull. One badly preserved humerus, half of another, a radius, five metacarpals, three phalanges, a fibula, and fragments of a scapula complete the list. The specimen is No. 970 of the American Museum fossil reptilian collection.

The Skull.

The condition of the sutures, the fact that the rostral bone had not ankylosed with the premaxillaries, and that the so-called epoccipital bones, the lozenge-shaped ossicles around the margin of the frill, were not sufficiently coössified with the latter to prevent the loss of some of them, give evidence that in spite of the enormous size of the animal it had not yet reached maturity. The maxillary teeth have dropped out of position with one exception, a tooth which lay deep in the alveolar channel of the right side. Other teeth, found loose in the matrix, were clearly of the upper series and are shown in position in the photograph (Plate LIX). The *rostral bone* is highly rugose, due to the impressions of blood-vessels over its surface showing it to have been closely sheathed in horn. The forward border is a full, gentle curve, while the inferior margin is straight and nearly horizontal when the bone is in position, as in most Testudinata. This, together with the form of the predentary bone, which curves upward towards the tip, would seem to indicate a cutting beak very turtle-like in aspect, as one would be led to expect from somewhat similar feeding habits, rather than the trenchant, downwardly curved, raptorial beak usually given to the restored *Triceratops*. The fact that in *Chelydra*, where the upper beak is hooked, the bone which supports it is of similar form, may be taken as corroborative evidence.



TRICERATOPS SERRATUS *Marsh.*

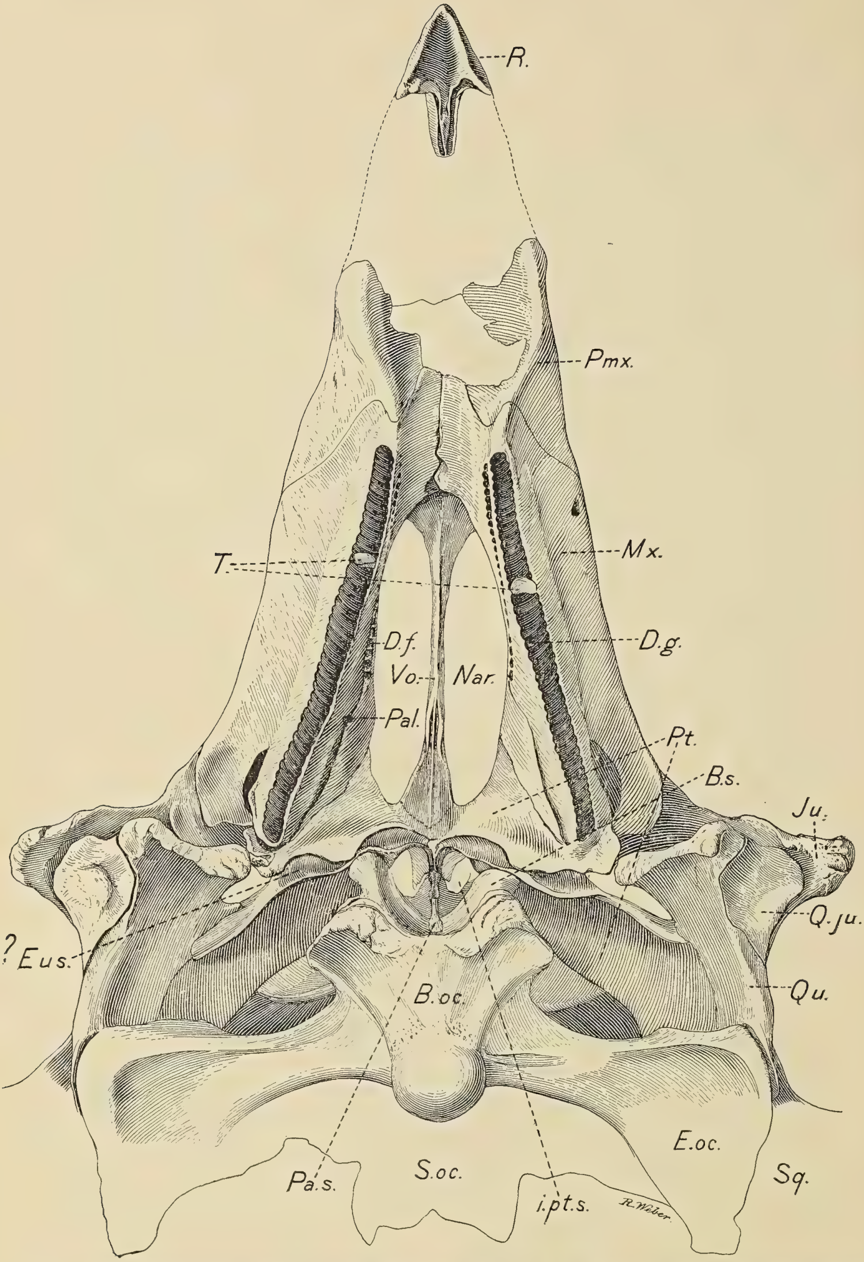
Palatal aspect of skull, with frill. $\times \frac{1}{15}$. (Extreme length about 6 ft. 4 ins.).

Palatal Aspect.

The *premaxillaries* are only in part preserved. The *maxillaries* are heavy bones uniting anteriorly in the median line, in front of the narial fenestræ, by a pronounced dentate suture. Anteriorly the premaxillaries overlap them above and posteriorly they bifurcate, one limb, the dorso-lateral, running obliquely outward and backward to join the jugal, while the postero-ventral limb unites posteriorly with the pterygoids. The maxillaries thus form the anterior and about two thirds of the lateral walls of the large narial fenestræ. In the palatal face lies the alveolar channel, sculptured transversely into a number of shallow grooves, incomplete sockets in which the teeth were formed, forty in the right channel and forty-two in the left. The dental channel, is 482.8 mm. in length with an average width of 30 mm., which is somewhat less than its original measurement, owing to crushing. Other measurements may be found in the table on page 694. As in the mandible, a row of dental foramina runs along the inner face of the maxilla, one foramen being opposite each alveolar groove, through which passed the blood-vessels needful for the rapid forming of teeth in the dental magazine. The external face of the bone also bears two such foramina.

The *vomer*, or 'prevomer' as determined by Broom,[1] is a slender rod-like bone bridging fore and aft the space of the narial fenestra. Anteriorly it is dilated into a flattened rhombic expansion articulating by a squamous suture with the united maxillary bones. Passing backward there appears a median ventral keel giving the bone in its narrowest part, about the middle, a triangular section. Further to the rear the lateral edges bend downward to the level of the median keel and then rise again to their former level, where they give rise to thin plate-like expansions which are embraced at their posterior end by the pterygoid bones. Dorsally viewed the vomer is seen to become trough-like, the depression being about the width of the shaft of the bone and running the

[1] Broom, R., Proc. Linn. Soc. N. S. W., 1902, pt. 4, pp. 545–560.



Triceratops serratus Marsh. Palatal aspect of skull. × 1/9. *R*, rostral bone, *Nar.*, narial vacuity, *i.pt.s.*, interpterygoid space, *D.g.*, dental groove, ? *Eus.*, Eustachian groove (?).

length of the expanded posterior portion. There is no trace of paired elements in the vomer.

The *palatines* bound laterally the posterior part of the narial fenestræ, and are somewhat triangular in shape, with the base of the triangle meeting the maxillaries in a squamous articulation somewhat overlapping the dental foramina. Posteriorly they are bounded by the pterygoids, and the anterior portion runs upward over the jaw until it ends in a large vacuity on the dorsal side. This vacuity is further bounded anteriorly and externally by the maxillary, and posteriorly by the pterygoid, and it lies above a point one third of the distance from the posterior end of the dental channel.

The *pterygoids* are large and irregular with peculiar channels, probably the eustachian canals, running obliquely from the articulation with the posterior end of the maxillaries to the median line; these channels are formed by thin, overarching ridges of bone which in their mid-length almost meet. The pterygoids form the postero-lateral margins of the narial fenestræ in the rear of the palatine bones and embrace the hinder end of the vomer. Anteriorly they are bounded by the palatine and maxillary bones and possibly by the ectopterygoids, though the last-mentioned cannot be located in this specimen [1]; the ectopterygoids are not suturally separated from the pterygoids themselves. Posteriorly the pterygoids are met by the basisphenoid and in the median line they nearly embrace the parasphenoid, or ' vomer ' of Broom. Laterally they are broad and thin plate-like expansions which pass outward and backward to meet opposing processes of the quadrate, though the precise limit of the pterygo-quadrate suture is not everywhere distinct.

The *quadrates* are well developed and firmly fixed in place by the pterygoids within and the quadratojugals without. They also pass backward and upward, forming, with the quadratojugals, the lower boundary of the infratemporal fossa. Posteriorly they join the squamosals, which are widely expanded to form the lateral elements of the frill. The

[1] Marsh, O. C., Amer. Jour. Sci. (3), XLI, p. 171.

quadrate is flattened on its ventral aspect and somewhat cylindrically concave on its dorsal surface. The head is elongated transversely to a length of 147 mm., the facet which articulates with the lower jaw being somewhat saddle-shaped. The posterior end of the quadrate is embraced between the exoccipital and the squamosal bones. The *quadratojugals* are comparatively small bones lying between the quadrates and the jugals. Dorsally they extend in thin, plate-like expansions between the aforesaid bones, and in their posterior portions form part of the infratemporal arcade, almost, if not quite, meeting the forwardly extending process of the squamosals.. In their ventral portion where the distance widens between the quadrates and the jugals the quadratojugals dilate into a thick, wedge-shaped mass to fill the gap. The greatest thickness is 89 mm.

The *occipital region* of the skull is rendered very massive to support the great weight of the head, the sutures between the various elements being closed. The occipital condyle is almost spherical, and has a diameter of 115 mm. It looks almost directly backward and but little downward. Anteriorly it merges into a heavy basioccipital and laterally into the exoccipitals, the limits of these three elements in the condyle itself not being discernible.

The *basioccipital* diverges into two stout limbs with heavy, rugose extremities, in front of which appear the pulley-like basisphenoid bones, the parasphenoid (' vomer ') arising between the limbs.

The *exoccipitals* run out laterally to join the quadrates and squamosals, overlapping the former and firmly articulating with the latter to afford a strong brace across the entire base of the frill. They thin away posteriorly and are, together with the supraoccipital, overlain by the largely developed parietals which form the median element of the frill.

The ventral aspect of the *frill* or crest is well shown in Plate LIX, and is without vacuities of any sort, although just behind the exoccipital bones the parietals are excessively thin. Vascular impressions occur on the posterior half of the parietal bones on either side, but there is no evidence of a

wide free margin sheathed with horn as in the frill of *Triceratops prorsus*.[1]

The squamoso-parietal suture is a squamous one for a short distance backward, the squamosal overlapping; but at the point where the suture bends outward it becomes a plain harmonic suture having but little strength, as is evidenced by the fact that in the specimen under consideration the squamosal bone had slipped dorsally past the parietal on the right side, while on the left the bones were flush with each other. In the type specimen of *Triceratops serratus* in the Yale University Museum both sutures, that on the left as well as on the right, have slipped. The frill thus seems to have afforded leverage to assist in moving and supporting the huge head with its weighty armament and also to have protected the neck against the assaults of enemies, but it seems hardly probable in the present species that the dorsal part could have withstood crushing blows without injury to the frill. The hinder margins of the parietals have decomposed somewhat and the marginal ossicles are here wanting, though most of them are present on the squamosals.

Dorsal Aspect.

The anterior part of the skull has been weathered off, as it formed the outcrop of the specimen, and much of the bone has been disrupted by grass roots even where it had not yet been exposed by erosion.

The *postfrontals*, with the exception of the horn cores, are entire and the underlying sinus is readily explored through the large postfrontal fontanelle (the parietal or pineal foramen of authors). This sinus is continuous with those of the horn cores and in turn with the space within the skull behind the orbits, but not with the brain case. It is more or less wedge-shaped, tapering dorso-ventrally as one goes forward, the anterior limit being just in front of the orbit. The flat roof is formed by the overlying postfrontal and frontal bones, while the sinus is laterally constricted into three chambers. The anterior chamber has a rather flat floor and is separated from

[1] Marsh, O. C. 1896. Dinosaurs of North America, pl. lx, fig. 4.

the median chamber by vertical pillar-like bones, one on either side, which serve also to support the antero-internal portions of the horn cores. The floor of the second or largest chamber is deeply excavated, and it is this chamber which communicates with the horn-core sinuses by openings in the lateral walls. The posterior chamber, lying just beneath the fontanelle, is small and round, and in the specimen in question has a small pencil-like bone running obliquely from the left lateral wall to the floor, after the manner of a flying buttress. There is no indication of a pineal foramen opening into the brain case which lies directly beneath the above sinus; hence the Ceratopsia agree with other Dinosauria in this respect. The postfrontal fontanelle closes in old animals, as in the type skull of *Triceratops prorsus*, which is that of a fully adult though comparatively small animal, and is thus analogous to that in the skull of the human infant.

The loss of the frontals and nasals from our specimen renders possible the study of the interior of the skull, the bones of which are admirably preserved, and while the entire skull gives an appearance of massiveness, the individual bones are comparatively thin, but so constructed as to brace in the most admirable manner the portions of the skull subject to strains and impact, especially beneath the horns.

The *frill* viewed from above presents much the same relative expanse of bone as is shown in the ventral aspect except that the squamosals now extend forward and upward to the base of the horn cores. Anteriorly they are bounded by the jugals, the infratemporal vacuities, and the quadrates. On one squamosal, and to a less extent on the other, a ridge for muscular attachment extends diagonally upward and backward across the posterior portion of the bone. The parietals have the same extent as in the ventral view except that here they overlie the occipital bones and articulate with the postfrontals at about the posterior limit of the horn cores. The supratemporal vacuities open forward beneath the postfrontals and above the parietals into the main sinuses of the skull. Large blood-vessels had their exit through these vacuities, their branches being deeply impressed into the surface of the parie-

tals and to a less extent into the squamosals, thus implying a compactly fitting integument. The base, especially of the right horn core, is well preserved. It is extremely hollow, but with a shelf-like circular projection of bone running around the inner wall just above the level of the postfrontal bones without, and doubtless to aid in resisting the thrust of the latter bones when lateral pressure was brought to bear upon the horns. Around the outside base of the horn is a horizontal ridge which may have supported the base of the horny sheath. The *orbits* are nearly circular and are surrounded by a thickened ridge of bone, especially in front. The downward and outward crushing of the left horn core has partially closed the left orbit, adding to the sinister expression of the skull.

The Lower Jaw.

The left *mandible*, which is admirably preserved, consists of dentary, surangular, and coronoid, with a full magazine of thirty-nine vertical rows of teeth. On the inner face is a row of thirty-eight dental foramina, and the meckelian groove on the inferior face is wide and deep, but was covered by the thin, plate-like splenial which, though lying detached in the quarry, presents a perfect contact when placed in position. Cope [1] claims that in *Hadrosaurus* it is the splenial which contains the magazine of teeth. Whether or not this be true of *Hadrosaurus* it is certainly not true of *Triceratops*, in which the magazine is contained in the dentary in the normal manner. The teeth arise in alternate series in the successive vertical rows, only one series being in full use at one time, though those of the secondary series, arising between the teeth of the primary series, show partial wear, while in the posterior part of the jaw individual teeth of the primary set are already succeeded by tertiary teeth. The vertical worn faces of the teeth present the surface known to mathematicians as an hyperbolic paraboloid or warped surface; the whole mechanism reminding one of a slightly twisted saw with alternating higher and lower teeth. Marsh notes the fact that in the Ceratopsia the teeth are double-rooted, a feature almost unique among reptiles. This

[1] Cope, E. D., Amer. Naturalist, July, 1883, p. 775.

seems to have been brought about by the mechanical necessity of a base widened transversely to meet a lateral strain in the shearing process of mastication and the subsequent constriction of this base into an inner and outer pillar due to the crowding of the crowns of adjacent teeth set at a lower level. There could have been no lateral movement in mastication, but a chopping motion, possibly with a slight orthal movement combined with it. The food gathered by the cutting beak was probably chopped into short pieces by the teeth, being kept in the mouth by the muscular wall of the cheeks. It is doubtful whether the gape of the mouth had a posterior extent further than the anterior end of the tooth series, as otherwise the portions of food chopped off, falling outside of the lower teeth, could not have been retained in the mouth.

The alveolar grooves are equally developed in the inner surface of both inner and outer walls of the dental channel and not in the inner surface of the outer wall only as in *Trachodon* (*Hadrosaurus*) as shown by Lambe.[1] This is due to the fact that in *Triceratops* the crowns of the teeth do not form so flat a tassellated pavement when viewed from within; their position in the jaw being more nearly vertical than in *Trachodon*.

Measurements.

Length of skull (estimated)	2160 mm.
Width across frill	1578
Maxillary bones, length	672
" " length of dental channel	482.8
" " average width dental channel	30
Premaxillary bones, width at posterior end	177
Vomer, length	410
" width at anterior end	70
" width of shaft	15
Palatine bones, length	293
Occipital condyle, diameter	115
Foramen magnum, width	47
" " height	39
Basioccipital bone, width	280
Exoccipitals, distance from tip to tip	790

[1] Lambe, L. M., 1903, Ottawa Naturalist, Vol. XVII, pp. 136, 137; Osborn, H. F., and Lambe, L. M., 1902, Contributions to Canadian Palæontology, III, Part II, p. 73.

Exoccipitals, greatest fore and aft width	260 mm.
" least " " " "	147.5
Parietal bones, ventral aspect, length	808
" " " " least width	742.5
" " " " greatest "	115.4
Squamosal bones, ventral aspect, length	820
" " " " width	355
Postfrontal fontanelle, height	97
" " width	130
Infratemporal vacuity, length	130
" " height	52
Right horn core, longitudinal diameter at base	235
" " " transverse " " "	215
" orbit, length	170
" " height	115
Lower jaw, length of dentary	672.5
" " greatest depth to summit of teeth	183
" " height of coronoid	287.5
" " length of dental channel	324

Article XXXI. — THE SKULL OF CREOSAURUS.

By Henry Fairfield Osborn.

The skull of the Jurassic Carnivorous Dinosaur *Creosaurus* is represented by two specimens, from the Bone Cabin Quarry, in the American Museum Collection, Nos. 600 and 666, which supplement each other admirably and give a very complete knowledge of all except the palatal region. The side and back view of No. 600 is presented in figures 1 and 2.

The chief features are: (1) the presence of three preorbital fenestræ, (2) the great elongation of the facial region, (3) the abbreviation of the temporal region, (4) the wide extension of the parietals on the occiput, (5) the deep depression of the quadrate and its rounded articular connection superiorly with the squamosal.

Proportions. — The skull is relatively high and narrow, the chief measurements being as follows:

	No. 600.	No. 666.
Length, occipital condyles to premaxillæ......	810 mm.	885 mm.
Depth, parietal crest to distal extremity of quadrate................................	415	430
Width of occiput across parietals.............	...	230
Vertical measurement of quadrate............	205	235

Openings. — The openings are placed as follows: (1) the paired narial openings, of elongate oval form, at the sides of the snout, bounded by the premaxillæ, nasals, and maxillæ; (2) the greatly abbreviated supratemporal fenestra; (3) the deeply extended latero-temporal fenestra (the post-temporal fenestra is entirely closed, and there is no pineal opening); (4) there is a slit-like foramen between the quadrate and quadratojugal; (5) the orbital openings are deeply vertical; (6) the preorbital fenestra, f', is by far the largest vacuity in the skull, and is bounded by the maxillaries, prefrontals, and jugals; (7) a much smaller second preorbital fenestra, f'', is bounded entirely by the maxillaries; (8) the third preorbital fenestra, f''', lies between the premaxillaries and maxillaries, and is very small.

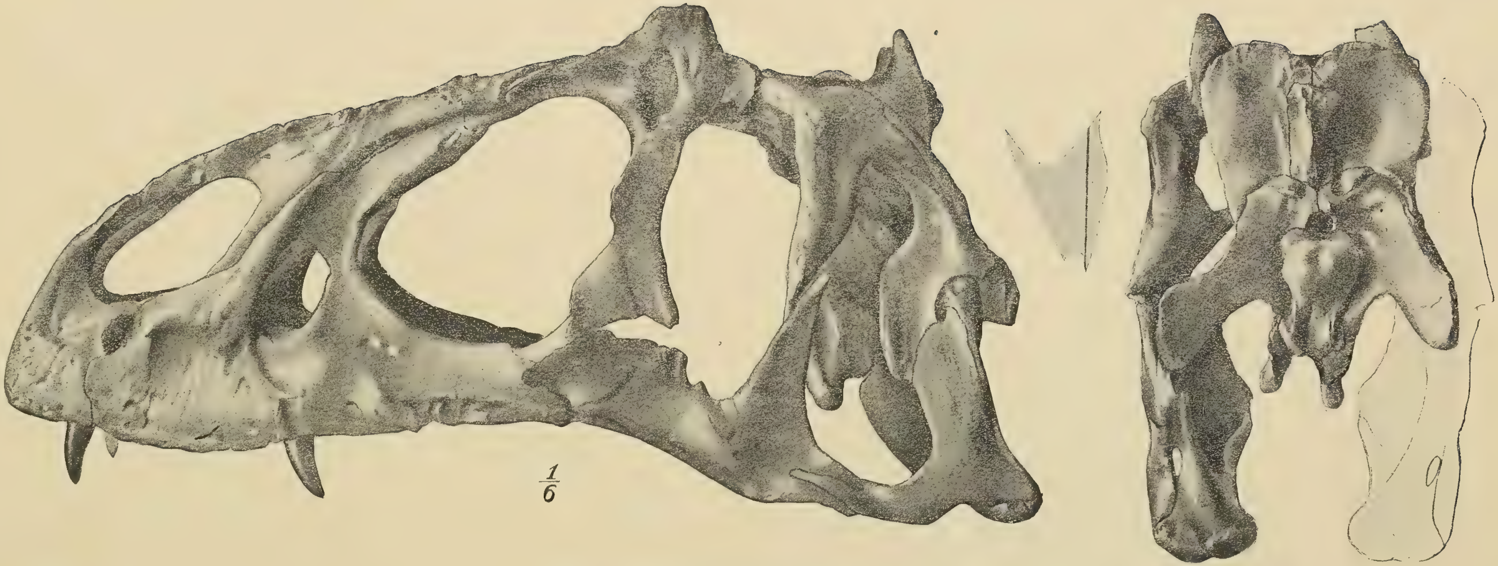


Fig. 1. Skull of *Creosaurus atrox* Marsh. × 1/6.

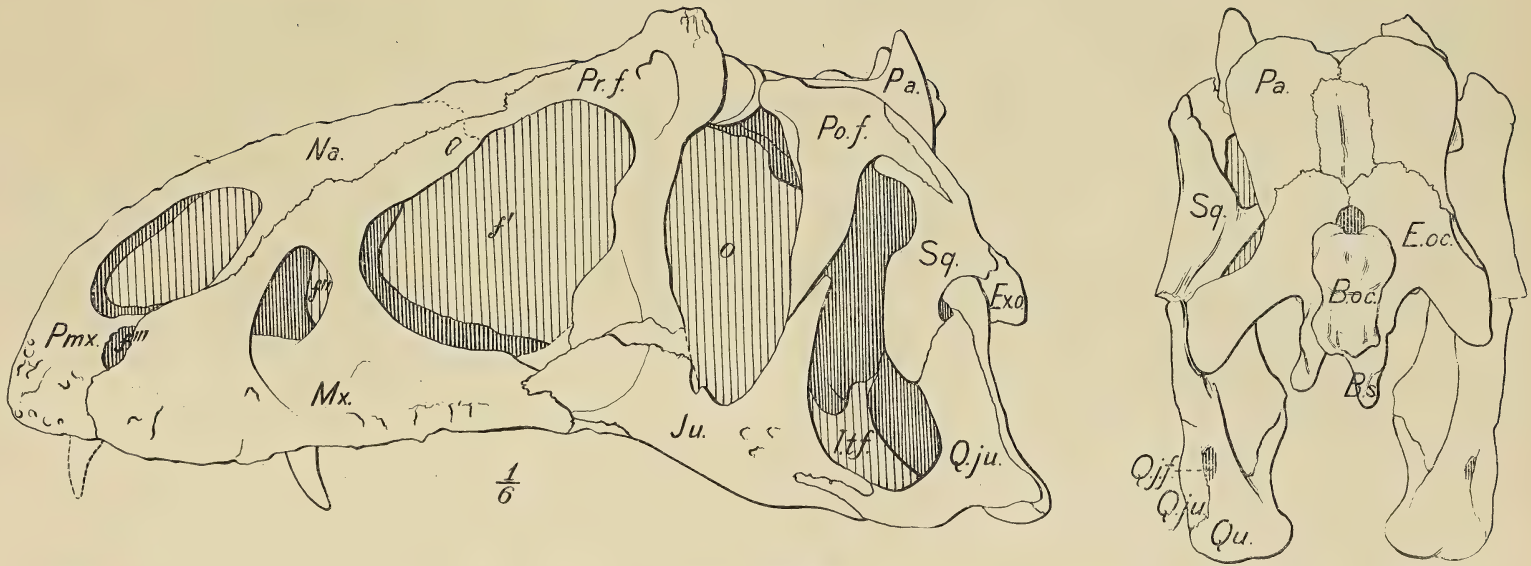


Fig. 2. Key to Fig. 1.

o, orbit.
f', first preorbital fenestra.
f'', second preorbital fenestra.
f''', third preorbital fenestra.
l.t.f., laterotemporal fenestra.
Q.j f., quadratojugal foramen.

The *premaxillaries* retain the alveoli of five teeth, and resemble the type premaxilla of *Creosaurus atrox*, a genus which, however, has not yet been clearly separated from *Allosaurus*.[1] The *maxillaries* contain the alveoli for from 16 to 18 teeth. Length, 460 mm. The *nasals* are remarkably elongate, 470 mm. (No. 666), and gradually increase in breadth posteriorly; in No. 666 they are continuous back to the frontals; in No. 600 there is a fracture or suture above the preorbital fenestra which is not observed in No. 666, and, therefore, is apparently accidental. The *frontals* are extremely short, 140 mm. in No. 666, extending back to a point midway between the supratemporal fossæ. The superior portion of the parietals is also abbreviate, but laterally and posteriorly they form two large transversely extended vertical plates constituting the crest or superior and lateral portions of the occiput. The narrow *supraoccipitals* apparently extend partly between the parietal crest above; below they are in contact with the conjoined exoccipitals. The *exoccipitals* unite in the median line above the foramen magnum and extend outward in two broad winglike plates with which the paroccipitals are coalesced. The *basioccipital* alone enters into the prominently convex condyle.

The lateral portions of the occipital region are formed by the posterior plates of the *squamosals*, which fill the bordering angle between the parietals and paroccipitals; in side view the squamosals are indented by a spur of the postorbito-frontals, and send a descending process for articulation with the ascending process of the quadratojugals. The *quadrates* are vertically extended with a singly convex head above for a jointed articulation with the squamosals, and a doubly convex transversely extended distal extremity for union with the articulars. The *quadratojugals* are placed on the outer sides of the quadrates, and are shorter elements than the jugals. The *jugals* are triradiate bones articulating with the quadratojugals, postorbito-frontals, and prefronto-lachrymals, respectively. The elements bounding the orbits anteriorly, uniting with the jugals and maxillaries below and with the nasals and

[1] This matter has been carefully discussed by S. W. Williston: 'The Dinosaurian Genus Creosaurus, Marsh.' Amer. Journ. Sci., Vol. XI, 1901, p. 111.

frontals above, are considered to represent a complex composed of the *prefrontals* and *lachrymals;* they are surmounted by a stout tuberous process which is deeply excavated on the antero-external surface; this process may have supported something in the nature of a low dermal horn.

Below the condyles the basioccipitals descend abruptly downward and backward; on each side of this downward projection are the apparently inferior plates of the exoccipitals. From these inferior plates two still more depressed wings extend downward, which probably represent antero-inferior processes of the basisphenoids for articulation with the pterygoids.

Lower jaw. — In the *lower jaw* the articulars, angulars, and dentaries are clearly determinable. The suture between the coronoid and angular is faintly determinable posteriorly, the coronoid being depressed. The convex element extending along the inner side of the dentary but firmly coalesced with it may represent a presplenial; if this is truly the presplenial it appears to extend as far forward as the symphysis. There are apparently sixteen alveoli for the laterally compressed lower teeth in the dentary.

A fuller description of these skulls will appear in a forthcoming memoir.

Index to Volume XIX.

[New names of higher groups, genera, species, and subspecies are printed in heavy-faced type, as are also the main references in a series of references to species, etc.]

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(*Continued on 3d page of cover.*) 961